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MISSOURI BOTANICAL GARDEN BULLETIN

VOLUME XXII

WITH 55 PLATES

1934

ST. LOUIS, MISSOURI

PUBLISHED MONTHLY EXCEPT JULY AND AUGUST,
BY THE BOARD OF TRUSTEES

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Missouri Botanical Garden Bulletin

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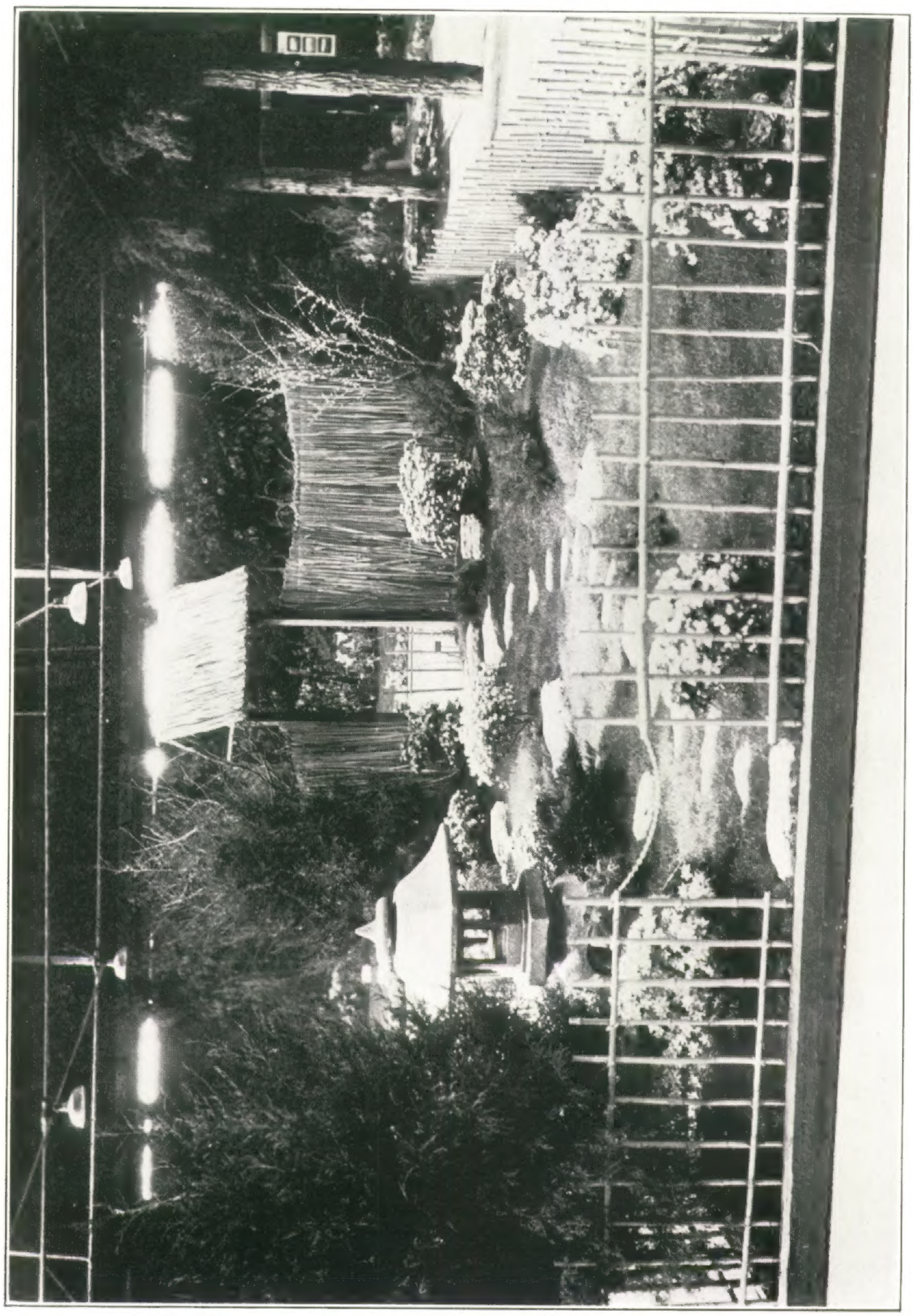


THE W. A. MANDA MEMORIAL GARDEN AT FOURTEENTH NATIONAL FLOWER AND GARDEN SHOW, ARENA, MARCH 25 — APRIL 2.

Missouri Botanical Garden Bulletin

Vol. XXII JANUARY, 1934 No. 1

FORTY-FIFTH ANNUAL REPORT OF THE DIRECTOR

Gentlemen:

I have the honor to submit herewith the forty-fifth annual report of the Director.

By tradition at least, these annual reports have dealt only with the accomplishments of the past years. No attempt at prophecy or expressions of hope have lightened the somewhat dull recital of events which necessarily go to make up the life of a botanical garden. While the routine nature of the activities of such an institution is recognized, there are apt to be a few special features calculated to break the general monotony. For the year 1933 these range all the way from the four special exhibits made at the National Flower Show to the building of a dam for the lake in the North American Tract, the remaking of the iris garden, and the construction of a soil shredder, with the necessary covered bins for leaf mold and different kinds of soil so constantly in demand. Since there is no single outstanding accomplishment, it seems better to take up the various items under their appropriate headings rather than to summarize them here. For those interested enough to read the entire report the year will stand as one of considerable progress in many different directions. For those who do not read it all no summary would be possible that gave a complete picture.

MAIN CONSERVATORIES

The palm house, the cycad-fern house, the economic house, the coffee and banana house, which constitute the range known as the main conservatories, together with the Linnean house, were treated somewhat at length in the anuual report for 1932. Since all the plants in these houses are established in the ground, there have been comparatively few changes. Some additions have been made to all of these collections, notably in the succulent house where the exhibit of cacti and other succulents has grown to be one of the most representative of its kind in the country. Additions have also been made to the collections in the palm house, probably the one attracting the most attention being the great bulbs of *Amorphophallus Titanum* obtained from Sumatra. These have produced six huge leaf stalks which are very different from anything ever shown in this house. Unfortunately, the flower bud from one of the bulbs was broken in transit but the second bulb is now throwing a shoot which indicates that it may possibly produce a flower.

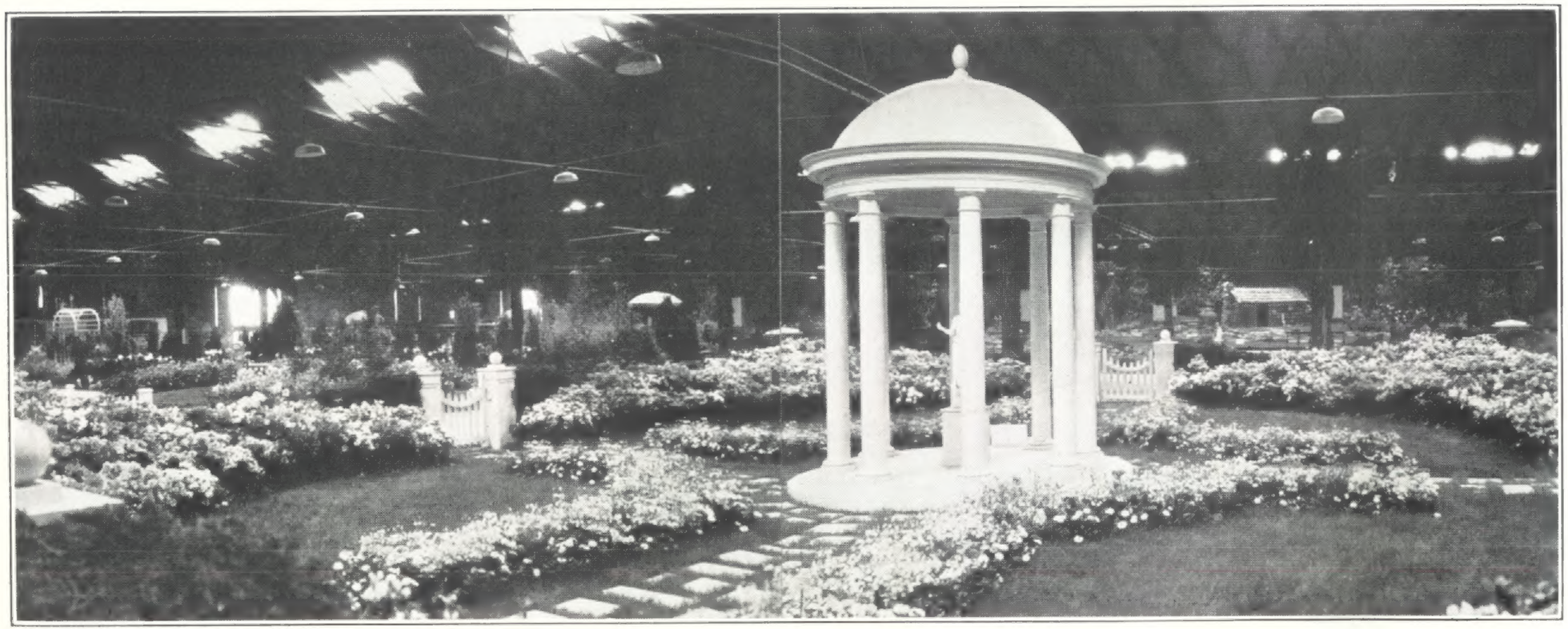
INDOOR FLORAL DISPLAYS

The annual orchid show was staged the week of January 9 and lasted until February 26.

On Saturday, March 4, the cineraria show was completed and continued until Sunday, March 26.

During the early part of the year much time and effort was devoted to the growing of plants for the National Flower and Garden Show at the Arena, March 25–April 2. The Garden was assigned a central position in the "A" building, consisting of 2,400 square feet. A formal azalea garden was designed for this area, with a temple for the central feature. In addition to the azaleas there were four beds of malacoides primroses, English daisies, and polyantha primroses, and the garden was surrounded by an evergreen hedge (pl. 2).

Owing to the sudden death of Mr. W. A. Manda, who had planned to exhibit at this show, the Garden was called upon to install an additional display in the location assigned to him. A simple Japanese garden, enclosed by a bamboo fence, was built. Stepping stones led up to a gate flanked on either side by a rush fence of cat-tails, and beyond this



FORMAL AZALEA GARDEN COVERING 2,400 SQUARE FEET AT FOURTEENTH NATIONAL FLOWER AND GARDEN SHOW, ARENA, MARCH 25 — APRIL 2.

DISPLAY OF ORCHIDS AT FOURTEENTH NATIONAL FLOWER AND GARDEN SHOW, ARENA, MARCH 25 — APRIL 2.

fence was a little garden with regal lilies planted against a background of junipers. A white-flowering redbud, a plum, dwarf junipers, and an imported Japanese lantern completed the setting (pl. 1).

The Garden also featured a display of blooming orchids which were staged in the center of the main building. This was regarded as one of the main attractions at the Show and received a first prize. A pyramid 20 feet high contained over 5,000 orchid plants representing the best of the Garden's Cattleyas, Laeliocattleyas, Brassocattleyas, Paphiopedilums, Phragmopedilums, Dendrobiums, Cymbidiums, Oncidiums, Phaius, Chysis, Epidendrums, together with various species of botanical interest (pl. 3). Orchids from crosses of Dendrobiums and Laeliocattleyas, raised from seed at the Garden, were likewise included. A duplicate of the bouquet of orchids annually presented by the Garden to the Queen of the Veiled Prophet was shown in an electrically refrigerated show-case near this central exhibit.

Although it was too early in the season to display water-lilies in perfection, a fairly successful attempt was made to bring these plants into bloom, and a small water-lily garden was established, including the new yellow lily "St. Louis," for which U. S. Plant Patent No. 55 had been granted (pl. 4). This new lily was deemed worthy by the judges of the award of the Henry Shaw gold medal pictured in the 1932 annual report. However, the Garden declined to accept the medal although the honor of receiving the award was much appreciated. Consequently, the next time the medal is awarded will be the first time it will have been actually presented to the winner.

The members of the Society of American Florists and Ornamental Horticulturists attending the forty-ninth annual convention were entertained at luncheon in the floral display house on March 30. At this time a special exhibit illustrating the responses of plants to various environmental conditions was arranged, which comprised some of the following subjects: plant nutrition, seed germination, translocation of mineral elements in the plant, growth responses in various types of plant containers, effect of acidity and alkalinity on plant growth, plant growth in air-tight containers, growth

responses of pot-bound plants, photoperiodism, influence of X-rays on plant growth, growth responses in various rooting media. There were also demonstrations of some of the experimental work being carried on, including orchid culture, preservation of cut flowers, water-lily culture, bubble bouquets, etc.

During April stellate cinerarias, schizanthus, annual chrysanthemums, and marguerites were displayed, and during the month of May snapdragons, lilies, clarkias, salpiglossis and pelargoniums were added.

From May 19 to May 21 the St. Louis Horticultural Society held its spring show in the floral display house. In late May the hydrangeas were displayed, these being gradually replaced in June with fuchsias and fancy-leaved caladiums. During the summer months caladiums formed the main display.

On October 5 the Queen's bouquet was exhibited, and on October 7–9 the annual dahlia show of the St. Louis Horticultural Society was staged.

As in years past, the chrysanthemum show attracted many visitors. More work was put on the show in 1933 than ever before, the design being more elaborate. Chinese moon-gate structures were built on either side of the display house and at the rear a Japanese house. A small elevated garden, with bamboo gate and fence, constituted a focusing point for the plants. Five thousand cat-tails were used in the rush fence which formed a background for the displays. One hundred cascade chrysanthemums were draped over the fence at the south end of the house, this being the largest number of cascade chrysanthemums ever displayed at one time. Thirty-four large hanging baskets of chrysanthemums were suspended from the roof, and twenty-four smaller baskets were placed in various parts of the display.

During the first week in December the largest poinsettia display in recent years was installed as a Christmas show. Fifteen hundred poinsettias in red, pink, and white were displayed, and as accessories, stevia and "Christmas Gold" and "Vivian Martin" chrysanthemums were used.

DISPLAY OF HYBRID WATER-LILIES ORIGINATED AT THE GARDEN, FOURTEENTH NATIONAL FLOWER AND GARDEN SHOW, ARENA, MARCH 25 — APRIL 2.

1927

1933

TWO VIEWS SHOWING DEVELOPMENT OF PLANTING AT TROPICAL STATION.

(Note same street lamp in each picture.)

FLORAL DISPLAY RANGE

Leading from the large house in which the regular floral displays are staged is the aroid house containing a varied collection of plants belonging to this group. For the past few years the alcoves in this house have contained blooming orchids, brought in from Gray Summit at least once a week. There has not been a day during the past year in which visitors to the Garden could not see orchids in at least several varieties on display. This, of course, is quite independent of the annual orchid show. Going from the aroid house through the bromeliad house one comes to a new display which, for want of a better name, is called the "Plant Curiosity House." Here have been brought together a large number of unusual plants, which attract little, if any, attention when kept in the general collections, but when segregated and bearing suitable labels prove to be attractive as well as instructive to visitors. Here is likewise to be found a representative collection of aquatics or "aquarium plants" established directly on the benches which are constructed to hold water. The wide interest in these plants justified the Garden to begin featuring them as early as 1919 (Mo. Bot. Gard. Bull. 7:63. 1919), when, in cooperation with the St. Louis Aquarium Society, especially prepared aquaria were installed in the aroid house. Besides the display of fancy fish, there was an exhibit of various aquatic plants so indispensable for maintaining the life of fish.

Some thirty different plants suitable for aquaria were maintained permanently, and during succeeding years on several occasions the Aquarium Society held special exhibitions in the floral display house, where the fish, together with suitable plants, were kept for a month or more. The new arrangement is more satisfactory than any previously devised, since it is possible to display the aquatics in a more natural way and the plants themselves can be seen and appreciated in a manner impossible when contained in small aquaria with fish.

PLANTS IN THE PLANT CURIOSITY HOUSE

AQUATICS

Latin Name	Popular Name
Azolla caroliniana	Floating fern-leaf
Cabomba caroliniana	Fish grass
Ceratopteris thalictroides	Water fern (baby and adult)

Latin Name	Popular Name
Colocasia antiquorum var. *Fontanesii*	Black caladium
Colocasia antiquorum var. *illustris*	Imperial taro
Colocasia neo-guineensis	Dwarf spotted taro
Cryptocoryne auriculata	Submerged spathe plant
Cyperus alternifolius	Umbrella plant
Cyperus Papyrus	Egyptian paper plant, papyrus
Eichhornia crassipes	Water hyacinth
Elodea canadensis	Ditch moss or water weed
Lemna minor	Duck weed
Limnocharis Humboldtii	Water poppy
Marsilea quadrifolia	Water clover or pepperwort
Myriophyllum proserpinacoides	Parrot's feather
Myriophyllum scabratum	Water milfoil
Pilularia globulifera	Ball flower
Pistia Stratioides	Water lettuce
Salvinia natans	Floating gem
Thalia dealbata	Missouri water canna
Thalia divaricata	Tropical water canna
Utricularia biflora	Bladderwort
Vallisneria spiralis	Eel-grass
INSECTIVOROUS PLANTS	
Darlingtonia californica	California pitcher plant
Dionaea muscipula	Venus fly-trap
Drosera rotundifolia	Sundew
Nepenthes, collection of	Pitcher plants
Pinguicula caudata	Fly-paper plant (butterwort)
Sarracenia flava	Trumpet pitcher plant
Sarracenia purpurea	Trumpet pitcher plant
BROMELIADS	
Ananas sativa	Pineapple
Billbergia Leopoldi	Vase plant
Billbergia pyramidalis	Torch flower
Cryptanthus zonatus	Zebra plant
Guzmania musiaca	Convict plant
Tillandsia Caput-Medusae	Octopus plant
Tillandsia Lindenii	Fan flower
Tillandsia usneoides	Spanish moss
FERNS	
Adiantum cuneatum	Maidenhair
Adiantum trapeziforme	Giant trapeze fern
Aspidium falcatum	Holly fern
Asplenium nidus	Bird's-nest fern
Davallia bullata	Ball-fern, Squirrel's-foot fern

Latin Name	Popular Name
Dieffenbachias, collection of	Dumb cane
Dracaenas, collection of	Dragon's blood
Platycerium aethiopicum	Staghorn-fern
Polypodium aureum	Harefoot-fern

ORCHIDS

Brassavola nodosa	Lady of the Night
Brassia caudata	Spider orchid
Bulbophyllum Medusae	Octopus flower
Catasetum maculatum	Monk's-hood orchid
Coelogyne Massangeana	Chain orchid
Coryanthes Hunteriana	Bucket orchid
Dendrobium crumenatum	Malay butterfly orchid
Dendrophylax Lindenii	Leafless orchid
Epidendrum cochleatum	Snail shell orchid
Lockhartia pallida	Braided orchid
Oncidium Oerstedii	Baby's bonnet flower
Oncidium Papilio	Butterfly orchid
Oncidium stipitatum	Dancing-girl orchid
Paphiopedilums, collections of	Lady's slipper
Peristeria elata	Dove orchid
Phaius grandifolius	Nun orchid
Phalaenopsis amabilis	White moth orchid
Phalaenopsis Lindenii	Pink baby moth orchid
Pholidota imbricata	Rattlesnake flower
Renanthera Storiei	Ladder orchid
Vanda caerulea	Blue orchid
Vanda teres	Stem leaf
Vanilla planifolia	Vanilla

MISCELLANEOUS

Abutilon hybridum	Flowering maple
Acalypha hispida	Chenille plant
Aeschynanthus lampogna	Fire-cracker plant
Aglaonema costatum	Spotted leaf
Aglaonema modestum	Chinese evergreen
Anthurium Andraeanum	Heart flower
Anthurium crystallinum	Satin leaf
Anthurium Veitchii	Corrugated leaf
Anthurium Warocqueanum	Green satin leaf
Aristolochia gigas var. *Sturtevantii*	Pelican plant
Aspidistra lurida var. *variegata*	Striped aspidistra
Begonia Feastii	Beef-steak begonia
Begonia Rex	Rex begonia
Bertolonia marmorata var. *aenea*	Copper leaf
Bowenia spectabilis	Fern-leaf sago plant (Australia)
Bowiea volubilis	Climbing onion
Calathea crotalifera	Rattlesnake flower

Latin Name	Popular Name
Caryota urens	Fish-tail palm
Ceropegia dichotoma	Indian parachute flower
Ceropegia Sandersonii	South African parachute flower
Ceropegia stapeliaeformis	Rat-tail plant
Ceropegia Woodii	Wood's potato vine
Cycas revoluta	Japanese sago plant
Cycas Rumphii	Malayan sago plant
Dorstenia Contrajerva	Artillery plant
Eucharis grandiflora	Amazon lily
Euphorbia splendens	Crown of thorns
Fittonia argyroneura	White mosaic leaf
Fittonia Verschaffeltii	Red mosaic leaf
Gynura aurantiaca	Rainbow leaf
Haemanthus albiflos	Cape paint-brush
Hedera canariensis	Variegated ivy
Helxine Soleirolii	Baby tears
Jacobinia magnifica	Baby ribbon
Lunularia vulgaris	Irish pie, Liverwort
Marchantia emarginata	Irish pie, Liverwort
Marchantia polymorpha	Irish pie, Liverwort
Mimosa pudica	Sensitive plant
Monstera deliciosa	Window leaf
Pandanus Sanderi	Stilt plant
Pandanus utilis	Screw pine
Pellionia Daveauana	Explosive flower
Pilea muscosa	Explosive flower
Peperomia Sandersii	Fancy pepper elder
Peperomia tithymaloides	Pepper elder
Philodendron cannifolium	Canna-leaf philodendron
Philodendron cordatum	Philodendron
Philodendron Lindenii	Velvet-leaf philodendron
Pothos celatocaulis	Shingle plant
Psilotum triquetrum	Forked club moss
Rhipsalis Cassytha	Mistletoe cactus
Rhoeo discolor	Baby in the cradle
Sanchezia nobilis	Noble plant
Sansevieria cylindrica	Mother-in-law's tongue, Bow-string hemp (dagger type)
Sansevieria zeylanica	Mother-in-law's tongue, Bow-string hemp (shield type)
Selaginella lepidophylla	Resurrection plant
Selaginella uncinata	Club moss
Spathiphyllum candidum	White spathe flower
Stangeria paradoxa	Fern-leaf sago plant (South Africa)
Tradescantia aureo-striata	Fancy wandering Jew
Urginea maritima	Sea-onion
Zebrina pendula	Wandering Jew

OUTDOOR PLANTINGS

Iris Garden.—The iris test garden of the American Iris Society was planted in 1928. In the ensuing years additional iris plants were received from various sources, some of these being planted in the test garden and others held in the nursery for lack of space in the beds. When this garden was originally planted some of the clumps were several years old, having been held in the nursery until enough varieties were available for planting the test garden. The removal, early in the spring, of the old rose pergola, which divided the iris test garden, necessitated a new plan for the iris garden. The garden was enlarged to care for the additional varieties of irises and at the same time provision was made for eleven beds of peonies. It was felt that a combined peony and iris garden would be more effective, both groups blooming at approximately the same time.

The first iris plants were lifted July 10 and the last peonies were planted October 24. Since the entire garden was remade, including gravel and grass walks, all of the 1,200 varieties of irises had to be labeled, removed, cleaned, planted in the nursery, and replanted in the iris garden after the field had been plowed and the beds shaped. This work could only be done after the routine work had been cared for, and this necessitated spreading the operation over a period of three months. If it had been possible to take the iris plants from one bed and reset them in another, the work would have been greatly simplified. The irises were originally planted in beds according to color, and if the color were not known it was almost impossible to locate the variety. The irises have now been arranged alphabetically, and it is believed that this will be the most convenient method for locating and labeling the varieties. Only a gardener who has attempted keeping a few dozen irises true to name can appreciate the amount of care and work required in a huge undertaking of this sort, when over a thousand varieties had to be removed, cleaned, dipped, and transplanted in a temporary location, and some weeks later, when the beds were ready, again dug and relocated in strict alphabetical order—not only all of the A's in the A bed and the B's in the B bed, but all of the varieties alphabetized under their respec-

tive initial letters. The peonies have also been arranged alphabetically. The completed garden now contains sixteen beds of irises, 12 x 75 feet, four beds 8 x 75 feet, each bed containing one row of irises and one of peonies. There are seven beds of peonies, 24 x 40 feet, and one bed of intermediate irises, also 24 x 40 feet. The garden contains a total of 1,214 irises and 170 varieties of peonies.

The irises in the seven beds in the west end of the Linnean garden were all lifted in early summer, and the beds replanted with irises, peonies, lilies, hemerocallis, and other perennials. For a number of years this end of the Linnean garden has been maintained as an iris display garden, but now, with the increased area in the new iris test garden, it is unnecessary to maintain two display gardens. The beds around the pools in the Linnean garden have also been replanted with new varieties of irises, peonies, and perennials. After the removal of one more bed of Japanese and Siberian irises next March, this garden will be maintained as a perennial garden, annuals being added for color effect during the summer months.

Rose Garden.—During February the soil from fifteen beds in the rose garden was removed and replaced with fresh soil, and this fall the favorable weather made it possible to refill fifty-one rose beds with new soil. The roses grew remarkably well during the past summer, and the appearance of the garden was much improved by the ground-cover plants which also served as a mulch. The plants used for this purpose were sweet alyssum, *Ceratostigma plumbaginoides* and *Plumbago capensis*. Over 200,000 gallons of water were applied to the rose garden during the latest of the four consecutive dry and hot summers. By dusting the roses once every two weeks with one of the sulphur dusts, the number of plants affected with black spot and mildew was negligible. The brown canker diseases are still interfering with the normal growth of the hybrid perpetual roses.

Other Gardens.—In the main garden the plants grew exceedingly well, since they were planted before the excessive heat of June. The plants in the Italian garden, however, were slow in becoming established; set out in June, they

received no beneficial rain until late July. Only the most conspicuous sections of the borders on the knolls were watered, as it was impossible to maintain all of them during the drouth period. The medicinal plant garden, water-lily pools, economic garden, and similar special collections were maintained much along the same lines as in former years.

Trees and Shrubs.—The fourth successive dry summer made the use of two tons of commercial fertilizer necessary for feeding weakened trees. The formula now used is past the experimental stage. Since 1928 it has contained more and more nitrogen, and at the same time the dose per tree has been more than doubled. The recommendations regarding dosage, which have proven effective in the Garden, are so much greater than any so far published that it seems unlikely they will be generally followed. Four years ago the use of a pipe gun to apply water and food underground to trees was tried. At that time the coarse material quickly clogged the sprayer which furnished the pressure. This year two guns of an improved type were built, and so successful was their use that feeding and watering were reflected in renewed growth five days after the application. During the summer many thousand gallons of water were applied by this method to newly planted trees and shrubs. These guns can be used at any pressure. In hot weather they save fifty per cent of the water since it is injected underground and cannot evaporate.

Dormant and delayed-dormant spraying required the use of 4,250 gallons of oil spray. A minor infestation of red spider was controlled by the use of 1,520 gallons of sulphur spray. Later in the summer 6,500 gallons of arsenate of lead were used in the Garden and Tower Grove Park. At that time several varieties of June bugs, in the adult stage, were feeding upon the leaves of sweet-gum and pin oak. The pruning of trees and shrubs required the time of four to six men for about four months. A large shipment of trees and shrubs was received from the Arboretum in November, but due to the extremely dry condition of the soil no planting can be done until next spring.

Lawns.—Over 9,560 square feet of bent grass were used to replace the clover sod around the lily pools. The clover sod

was then used to border the walks leading into the rose garden. A total of 189 loads of specially prepared soil and 28 loads of leaf mold were hauled into the rose garden. About the same amount of poor soil was hauled away, most of it being used to fill alongside the new road in the North American Tract. The new arrangement of the iris garden called for much additional new sodding, and considerable attention was paid to regrading and reseeding various places in the Garden.

Construction.—Four new storage bins were built of material which had accumulated in the Garden. They are roofed, have rock walls at back and end, tile dividing walls and concrete floors. They are designed for the storage of potting soil, leaf-mold, compost, and manure. Each bin holds forty-two truckloads, thus making it possible to store a considerable quantity of material to be drawn on and used in any kind of weather. A soil shredder, constructed from parts of a discarded power lawn-mower and an old paint sprayer, has greatly accelerated the process of making compost and leaf-mold available. Now only the current year's accumulation is piled to await rotting, thus eliminating the very unpleasant job of turning by hand large piles of material. While the labor necessary to produce usable compost has not been reduced, the work formerly done in three years is now concentrated into one year. The capacity of the machine is so large that at least five men are required to haul and feed the material while it is being shredded into the new bins. Another advantage is that it will remove the brick, rock, and even gravel, always found in such material, and so the soil and compost now available in the Garden is of a better quality.

A new dam was built at the west end of the lake in the North American Tract to replace the old one which had disintegrated and permitted the lake to become dangerously low. The new dam creates a lake 575 feet long with an average width of ninety feet and a maximum depth of over six feet. Over a ton of reinforcing steel and forty cubic yards of concrete were used in its construction. Almost seventy-five cubic yards of clay were taken from the excavation, some of which was used as a temporary dam during construction. An in-

jector was rigged up on the power sprayer to keep the excavation dry. During the last week it operated eighteen hours a day. The short creek below the dam was regraded, and the bottom and part of the sides were lined with rock set in concrete to prevent erosion. Sod was then placed above the rocks. A new cinder road was built from the head of the lake to the foot-bridge at the eastern end of the creek. The foot-bridge was widened to accommodate the truck, and the road carried from there to an established road west of the iris test garden. This makes it possible to drive completely around the North American Tract, and should prove a great convenience when mowing, spraying, or patrolling the tract.

The old rose pergola in the iris test garden was removed. The concrete footings were broken and used to fill in the 180 yards of seven-foot road built there. This section, comprising about five-sixths of an acre, was then plowed and graded. The new road and beds were bordered with 850 square yards of sod.

A new drainage system and catch basin were constructed near the storeroom; another was built in the knolls at the head of the cat-tail pools. This region was extremely low and required twenty-one loads of good soil to bring it to grade. Another drainage system was rebuilt alongside the citrus house and two new catch basins added.

Painting and Repairs.—The principal items of painting and repairs included the repairing and painting of the pergola in the Italian garden; the painting of the interior of the bromeliad house and building a rock retaining wall southwest of the floral display house; glazing and repairing ventilators and painting the growing houses; painting iron fence along Magnolia, Alfred, and Shaw Avenues; painting halls and rooms at the administration building, as well as the offices and rest-rooms at main entrance; painting and repairing roofs of the citrus and floral display houses; building stone bridge over creek; besides innumerable small items of construction and repair work. Mention should also be made of the considerable amount of construction work involved in the more elaborate settings now provided for the floral displays, such as building Japanese houses of stucco and bam-

boo, the erection of cedar walls, building of trellises, installing fountains, etc.

ATTENDANCE FOR THE YEAR 1933

(Recording turnstile count)

	Week-days	Sundays
January	12,163	16,899
February	8,533	6,423
March	8,149	10,526
April	9,466	14,213
May	17,997	14,646
June	14,388	7,013
July	18,313	8,652
August	24,486	11,068
September	13,943	9,239
October	15,151	12,743
November	32,786	35,892
December	10,388	18,740
	185,763	166,054
		185,763
Total		351,817

THE ARBORETUM

The nurseries continue to supply large amounts of material for permanent planting both at the Arboretum and in the city garden. Nearly 4,000 square feet of beds were planted this year with seeds of rare trees and shrubs obtained from all parts of the world. Over 3,000 young trees and plants were removed from the frames into nursery rows and about the same number transplanted from the seed-beds into the frames. Two hundred large pines, 150 spruce, 100 arborvitae, 300 junipers of various species were planted in the pinetum, and 600 large trees and shrubs distributed at various places. Nearly five hundred large pines were placed to form a background for the flowering cherry and apple orchards, and a considerable number of these trees likewise established south and west of the administration building. Over a thousand azaleas were added in the rhododendron dell and around the administration building. Twenty-two hundred large trees and shrubs were sent to the city garden.

The various orchards were regularly sprayed and pruned and all trees mulched with composted manure. About 80

acres of grass were sowed for hay and 10 acres of cow-peas planted and harvested. Five thousand square feet of sod were cut and laid and 40 acres seeded to blue-grass.

During 1933 seeds of 1,300 species of trees, shrubs, and herbaceous perennials were obtained from various botanical gardens and tested in the experimental greenhouse. Of this number, 300 species were sent to the Aboretum for trial. A large number of seeds from the Rock Collection, obtained through the University of California, were received during the summer. This included some 475 species of rhododendron, 144 species of Primula, besides many conifers, magnolias, etc., not previously tested for this climate.

Additions of Missouri Plants to Wild Flower Area.—With the primary object of augmenting the native flora at the Arboretum, the plant collector has visited during the past year fifty-eight counties in Missouri. Thirty-three species of plants were added to the collections, and seeds of twenty-nine additional species were also obtained. The following species were found as new to the state: *Cynoscidium digitatum, Epifagus virginiana, Heuchera arkansana, Lactuca saligna, Quercus heterophylla, Quercus rubra* var. *leucophylla.*

The following species which have rarely been collected in Missouri have been found and the original determination verified: *Croton Engelmanni, Helianthus angustifolius, Silene gallica, Quercus rubra* var. *triloba, Quercus Porteri, Spiranthus ovalis.*

In addition to collecting plants and seeds for the Arboretum, about one hundred species have been added to the plants of the Missouri herbarium, which is segregated from the general herbarium.

Orchids.—The blooming of hybrid orchids grown from seed at the Garden has increased greatly the interest in the collection, and distinct additions are being made by this means. The following list of seedlings which have flowered during the year will give some idea of what is in prospect when the thousands of seedlings yet unflowered come into bloom; the number of each hybrid may run into a hundred or more.

PARENTAGE	DATE GERMINATED	DATE FLOWERED
Laeliocattleya × "Moonbeam" (*Cattleya Schroederae* × *Laeliocattleya* "G. S. Ball")	Apr. 7, 1927	Mch. 15, 1931
Dendrobium × *superbiens* (*D. Phalaenopsis* × *D. undulatum*)	Dec. 3, 1928	Oct. 23, 1931
Dendrobium "Cassiope" × *D. nobile giganteum*	Dec. 8, 1927	Feb. 4, 1932
Cattleya luminosa aurea × *Laeliocattleya* "Ariel"	Aug. 25, 1927	Oct. 25, 1933
Laeliocattleya × "Roulers" (*Cattleya Fabia* × *Laeliocattleya* "Black Prince")	Jun. 1, 1928	Oct. 25, 1933
Laeliocattleya × "Waratah" (*Cattleya Trianae* × *Laeliocattleya* "Serbia")	Feb. 23, 1928	Nov. 10, 1933
Cattleya Whitei × *Laeliocattleya* "Ruby"	Jun. 1, 1928	Nov. 10, 1933
Cattleya Trianae × *Laeliocattleya luminosa aurea*	Mch. 25, 1927	Nov. 20, 1933
Cattleya "Iris" × *Laeliocattleya* "Golden Wren"	Jun. 1, 1928	Nov. 28, 1933
Laeliocattleya luminosa aurea × *Cattleya Dusseldorfii* "Undine"	Aug. 15, 1928	Nov. 26, 1933
Cattleya Gildenii alba × *C. amabilis alba*	Jun. 1, 1928	Dec. 5, 1933
Cattleya Trianae × *Brassocattleya Fournierii*	Apr. 7, 1927	Dec. 6, 1933
Cattleya Trianae × *Brassocattleya Maronae*	Jun. 14, 1927	Dec. 12, 1933
Laeliocattleya Herscentiae × *Cattleya Fabia*	Jun. 1, 1928	Dec. 14, 1933
Cattleya Trianae × *Laeliocattleya eximea*	Nov. 7, 1927	Dec. 14, 1933
Laeliocattleya Cooksonae × *C. Hardyana*	Jul. 3, 1929	Dec. 14, 1933
Cattleya Trianae "Liberty" × *C.* "Enid"	Jun. 3, 1928	Dec. 20, 1933

Completion of New United States Highway 66. — The completion of this new highway affords an additional means of reaching the Arboretum from St. Louis. At the time of the purchase of the land it was not anticipated that there would be two main highways leading direct to the main entrance, since of course Highway 50 (the Manchester Road)

was perfectly satisfactory. When the Highway Commission decided to bring the new highway back onto the Manchester Road at what is to be the entrance to the Arboretum, it was realized that in these two highways an approach to the Arboretum was afforded such as probably does not exist in connection with a similar institution any place in this country. The possibilities for the beautification of the new highway, because of the favorable territory through which it runs, were immediately appreciated. Interested parties in the various towns bordered by the highway formed what is known as the Watson-Antire Regionway Improvement Association, and through their activities there may be eventually a road to the Arboretum which will be as significant as the Arboretum itself.

The following article by Ellwood Douglass which appeared in the "St. Louis Post Dispatch," on October 22, discusses the development taking place at the Arboretum from the standpoint of an outsider. Because it gives the impressions of one who has not been in close contact with the project, and emphasizes things which would be more likely to appeal to the public, it is deemed more valuable than any discussion which might be prepared by a member of the Garden staff and is included here in full:

HOW SHAW'S GARDEN, IN 7 YEARS, HAS CHANGED GRAY SUMMIT WOODS INTO 1,625-ACRE BEAUTY SPOT

"As the dull stone takes form and meaning under the sculptor's will, so in seven years a lovely wilderness at Gray Summit has begun to show the contours of significance as the Shaw's Garden Arboretum.

"It is but the promise of grandeur, the beginnings of ordered beauty, though into these miles of hills and winding river banks have gone tens of thousands of trees and flowers from all countries, the finest landscape art and seven years of the unremitting care that little man must give his mother earth for everything he gets from her, though it be but a window-sill geranium.

"Here is an expanse of 1,625 acres, 34 miles from the city garden, larger than Forest Park and half a dozen average farms besides. The new Municipal Auditorium could rest in one of its nurseries. The entire Memorial Plaza would not cover its entrance pinetum. Olive Street from Broadway to Grand boulevard is not so long as the stretch of the Meramec River winding through the grounds.

HUNDRED YEARS FROM NOW

"A few years ago it was but a haphazard luxuriance, sprawling over blossomed hill-tops and junglesque ravines, untouched by the chastening, purposeful hand of the artist. A century hence, believes Director George T. Moore of Shaw's Garden, it will be a Mecca for lovers of beauty the world over.

"But that beauty will owe little to rule-of-thumb formality. The artists of tree and flower cherish the wilderness. Their part is not to remake it on some neat and maidenly scale, but to reveal and on occasion to enhance.

"So in this early development the hand of man has been most busy where it is least obtrusive. Here a road curves enchantingly beneath an oak, there a vista has been opened to a hill symmetrical as a Grecian cup, and where the little woodland trails seem most artlessly to thread a forest that shades them like a grotto, one comes surprisingly on epic panoramas.

"Exceeding slow has been its growth, slower in the depression years, for every cent of its income is drawn from the original Henry Shaw endowment. Unlike any other public garden in the world, it draws not a cent from any government source, and has never received a money gift since Shaw gave it to the people of Missouri 44 years ago.

"Yet the development has gone forward at a rate expressed in figures like those of mass production or a major engineering project — 25,000 evergreens, carloads of rhododendrons, 40,000 orchids (the finest show collection, by the way, in any public garden), miles of roads, acres of landscaping, 3,000 dogwoods, 2,000 oriental flowering trees, hundreds of thousands of native wild-flowers.

"Eight years ago the garden, driven by the city smoke which had devastated evergreens and made inroads on other growing things in town, purchased the first 1,500 acres at Gray Summit. It took a year to find out what it had. Growing naturally on the place were 100 kinds of trees and shrubs and 700 kinds of other native plants, including some wild-flowers first identified 30 years ago by George W. Letterman, Allenton school teacher, and rediscovered 30 years later at the Arboretum by his former pupil, John Kellogg, the garden's noted expert on Missouri flowers.

"To the trees and shrubs alone have been added 1200 varieties selected from all parts of the world. The pinetum already includes 3,000 evergreens, and 25,000 others in 200 varieties are growing in the nursery.

GROWTH OF THE PINETUM

"The pinetum lies at the entrance, behind a low native stone wall overgrown with the pink Missouri wild-rose, at the intersection of Manchester (U. S. No. 50) and Watson-Antire (new No. 66) roads. A few years ago it was a barren hillside above a shallow pond rimmed by baked and cracking clay.

"Now the evergreens in dozens of varieties wander gracefully along the slopes above a willow-shaded lake that mirrors the sky, decked with fleecy, highly ornamental clouds this month more than any other in St. Louis except June. Along the brow beyond the lake curves a graveled drive, deceptively as though there only for decoration. Beyond that hill, against the purple distance rises a far slope laid out in neat rows that in another spring or two will be thousands of blossoming Japanese cherry and crab-apple trees.

"To the right, along Manchester Road, stand the yellow brick stack and the silver-painted hot-houses of the finest orchid-growing establishment in this part, at least, of the world. In eleven greenhouses, along with thousands of plants acquired from many sources or torn from the jungle by the garden's own collectors, 15,000 young orchids, grown from the seed by the garden's secret process, are nearing maturity.

"Here, although the Arboretum is not open to the public, hundreds of St. Louisans every Sunday and holiday manage to see the orchids in bloom. And here the writer, who had visited every orchid show held in St. Louis, found a display as impressive as any he had seen—a 125-foot bank of flowering orchids.

"Hundreds each week have been taken in to be shown at the city garden, yet the orchid display has kept up as massively for two months past and will continue for months longer. Not only in numbers but in rarity it is impressive, for it includes such treasures as those new St. Louis-grown seedlings which have reached the blossoming stage, seven years after the microscopic seeds were planted in test tubes.

EVERGREENS UNHURT BY DROUTH

"Outdoors again, Superintendent Pring and Arboriculturist Bielmann led the writer to a closer examination of the evergreens. Alone of all the trees in this drouth-stricken region, they appear to have suffered not at all. Bielmann found they had grown an average of 18 inches this year, the same as last.

"Apparently thriving on hardship, Austrian pines have reached a height of 12 feet, in contrast to the three-foot dwarf Montana pine. The largest, an Austrian pine beside the administration residence, is 15 feet tall. L. P. Jensen, in charge of outdoor development at the Arboretum, said the Japanese red pine seemed one of the hardiest, while he had encountered most difficulty in establishing the yellow pitch pine, which grows natively as near as Ste. Genevieve.

"Busy with his tapeline, Bielmann remarked that he had found equal early growth in a 54-year-old pine cut down last summer at the city garden, once famous for evergreens. The tree had grown about 18 inches a year for 19 years, but, in the last 35 years, as development of the section near the garden multiplied the atmospheric smoke content, had grown less than two feet altogether.

"In a four-acre nursery near the residence, 25,000 baby evergreens, imported from all parts of the world, are thriving miles from city smoke. Dozens of varieties are on trial. Here, for example, is a battle between two kinds of hemlock, Canadian and Carolina. The Canadian is surviving the Missouri climate; the rows of Carolina hemlock have been decimated.

"Not only evergreen, but many thousands of other young trees in hundreds of rare varieties, native and exotic, grow in this and another nursery as large. They represent contributions of such agencies as the United States Department of Plant Introduction and the finest selections the garden could make in world-wide sources.

"A row of new bittersweet, sent out by the Government, is ripening later than the common bittersweet, but bearing several times as much fruit; there grows a pink Himalayan cousin of the snowy "bridal wreath," near it rows of "maple-leaf" sterculia, bearing leaves 20 inches in diameter, which has frozen to the ground each year, but grows 7½ feet in a summer.

"Not all the most rare are from distant countries. None is more rare than the white redbud, sprung from a lone tree—just south of the entrance in the city garden—vanquished by urban conditions two years ago after a gallant struggle which hundreds of St. Louisans had followed with pity and admiration. As it was reduced to a blackened stump, the garden started cuttings at the arboretum. Now, with 200 young trees growing rapidly, the indomitable parent has put forth fresh growth that may bloom again next spring.

"And not all the native rarities may be found in nursery. Along the four miles of graveled drives or the five miles of picturesque trails threading hidden beauty spots have been established thousands of the loveliest.

"Young dogwood trees, 3,000 of them, have been grouped for spectacular mass effects in their snowy blossoming time, and other hundreds of rare pink dogwoods, selected for depth of color, are being budded for similar groupings.

"Five carloads of rhododendrons, azaleas and kalmias, or mountain laurel, have been planted in a 'rhododendron dell.' Besides such importations as these, new collections are arriving almost weekly. The latest is the Rock collection of 500 packets of seeds from China, including many species new to this region.

"Hundreds of wild flowers, long since driven from the suburban woods, are sheltered in a 500-acre reservation, safe from vandalism. Many were found there in the initial survey, and some were rediscovered then, 30 years after they had been lost to this region in the march of progress.

"One of these was the tall blue larkspur rediscovered by Kellogg nearly a half century after his old schoolmaster, Letterman, pointed it out to him in the hills near Allenton. But like some others, even in the reservation, it was almost extinct, for the

lands had been overrun by grazing cattle before the Shaw's Garden purchase.

"Protected now, it has covered the lofty glades above the Meramec with its white and shades of blue. With it the cone flower, of which only 100 plants remained seven years ago, has dotted the glades with white, pink and red, and on the edges of the glades the yellow Missouri primrose with three-inch blossoms has returned in tens of thousands."

HOURS OF SUNSHINE RECORDED IN 1933

Month	City Garden	Arboretum
January	127½	152¼
February	159¼	172¼
March	144	152
April	175½	177½
May	194	179
June	326½	334¼
July	248	285
August	247¾	248¾
September	203½	205¼
October	214	214½
November	144¼	167¼
December	58	97
	2242¼	2385
		2242¼
Difference		142¾

Attention is again called to the excess of sunshine at the Arboretum as compared with the amount available at the city garden. At the time of year when sunshine is most necessary, namely, the months of November, December, January, February, and March, the Campbell-Stokes Recorder showed a total of 108 hours more at Gray Summit than in St. Louis. The total excess for the year at the Arboretum was about 16 hours more than the excess of last year, but, as pointed out in the 1932 report, this might mean little, since there is too much sun available for greenhouse plants during spring and summer and heavy shading is necessary. It is at the critical time of year when all the sun possible is needed for the plants in the houses that the advantages at the Arboretum are so manifest. Since last year's excess record for Gray Summit was 103½ hours during the five cloudier months, there was a trifle more sunshine during 1933.

TROPICAL STATION, BALBOA, C. Z.

The usual activities at the Tropical Station have been carried on much as in previous years. Weather conditions, which are so intimately connected with the care of orchids under more or less artificial conditions, have been very exceptional. In spite of the extremes of heat and cold, drouth and flood, the plants have in general done very well and a greater number have flowered than is usual, though most of them have been as much as two months out of season. All through July and August many of the large Cattleyas bloomed, and at the same time two of the *Vanda caerulea*. One of the latter bore six perfect flowers three inches in diameter, and the other, seven equally as perfect. Specimens of *Oncidium Kramerianum* also bloomed and there were numberless blossoms of the "Holy Ghost" orchid, as well as many others. In September and October *Cattleya Deckeri* bloomed freely, and was followed by the large white Sobralias which attract so much attention.

Due to the use of racks made of pipe from which to suspend hanging baskets, the orchids seem to adapt themselves to the varying conditions more readily, and fewer are damaged or killed than was formerly the case. The new arrangement has also reduced the care of the plants, and it is found necessary to hire no extra help beyond the one gardener regularly employed for taking care of the plants and the grounds surrounding the house and garden.

During the first years of the Tropical Station in its present location it was difficult to keep the plants sufficiently shaded. Now conditions are exactly reversed. The cocoanut palms planted by Mr. Powell give so much shade that it is frequently necessary to remove the lower leaves. When the trees attain a greater height it will probably not be necessary to do this. All of the trees planted have reached sufficient size that they afford protection from both the sun and wind, a very necessary and important function. Growing plants attached to trees has been found to be unsuccessful except in a few cases when all conditions are favorable (pl. 5).

The fight against insect pests is an extremely necessary and time-consuming part of the work at the Tropical Station.

One of the worst pests of the orchids is the cut-worm, against which no more modern method has been devised than spraying the plants with nicotine and killing the worms when they come to the surface.

Very little collecting has been done during the year, though several short trips have covered old ground that had not been explored for some time. No attempt has been made to bring in large quantities of plants, only exceptional specimens being added to the collection. The outstanding discovery of the year was the habitat of *Sobralia Powellii*. The home of this plant has eluded detection by all collectors, since Mr. Powell had no knowledge of the locality from which his single specimen came. Several plants were found and brought in, one of which bloomed on the same day as the original collected by Mr. Powell and long established at the Station, so that there is no question of its identity. A new lake which will be formed during the coming year by the building of a new dam, will make possible again the collecting of orchids by boat, a method used by Mr. Powell at the time when Gatun Lake was impounded. In this way it may be possible to add a number of new varieties to the collection at the Tropical Station.

ANNUAL BEQUESTS

The annual flower sermon, "On the wisdom and goodness of God as shown in the growth of flowers, fruits, and other products of the vegetable kingdom," provided for in the will of Henry Shaw, was preached at Christ Church Cathedral, on April 30, by Dr. George T. Moore, Director of the Garden and Engelmann Professor of Botany in Washington University.

The Trustees' Banquet Fund, inaugurated under the will of Henry Shaw, was not drawn upon during 1933.

The Gardeners' Banquet Fund was drawn upon in March for a luncheon in connection with the Forty-ninth Annual Convention of the Society of American Florists and Ornamental Horticulturists, and for the provision of turkeys at Christmas time for some of the employes of the Garden.

RESEARCH AND INSTRUCTION

The only change in the staff during the year has been the resignation of Dr. Roland V. La Garde, Scientific Assistant. No new appointments were made.

Dr. J. M. Greenman, Curator of the Herbarium and Professor in the Henry Shaw School of Botany of Washington University, in addition to curatorial duties, has directed the research work of graduate students in taxonomy and has given four advanced courses in plant geography, morphology and taxonomy; meanwhile he has continued his studies toward publication of further parts of "A Monograph of the North and Central American Species of the Genus Senecio," "A Synoptical Revision of the West Indian Senecios," "Studies of South American Senecios," and the preparations for a "Flora of the Southwest."

Dr. C. W. Dodge, Mycologist to the Garden and Professor in the Henry Shaw School of Botany of Washington University, has completed and published the first part of his "Foliose and Fruticose Lichens of Costa Rica" (Ann. Mo. Bot. Gard. **20**: 373-467. 1933), dealing with the families through the Pannariaceae of Zahlbruckner's System. As this work is provided with keys to all the species hitherto described from tropical America, it should become a very useful work for lichenologists dealing with tropical American floras. The manuscript dealing with the Stictaceae of this work is in an advanced state of preparation. Considerable material has been received for study from southern Brasil, Uruguay, southern Chile, and western United States, as well as large series of specimens of Stereocaulon from Japan and New Zealand. With the aid of an assistant, Dr. Morris Moore, supplied through the Science Research Fund of Washington University, further research on the morphology and cytology of yeasts and related organisms causing serious or fatal human diseases is in progress. Dr. Dodge, besides directing graduate work, has had charge of half the elementary course in plant morphology and of the course in mycology at Washington University. He has also published a short biography of Roland Thaxter (Ann. Crypt. Exot. **6**: 1-12, *1 pl.* 1933) and continued his work as editor of

"Biography, History, and Bibliography," of "Biological Abstracts."

Dr. E. S. Reynolds, Physiologist to the Garden and Associate Professor in the Henry Shaw School of Botany of Washington University, has essentially completed certain phases of research upon the toxic effect of plant juices upon fungi. Papers including the results of these studies are in preparation. Progress has been made toward the isolation and recognition of the toxic material, which, because of its easily oxidizable nature, is difficult to purify. Records of tree temperatures so far made seem to indicate a critical temperature region centering around the freezing point of water, and it is hoped that soon a somewhat extended and continued period of sub-freezing weather will make it possible to study further this critical region. For several seasons graduate students in the department have been studying the effects of ultra-violet and other radiations upon plants. In continuation of this subject a study of the effects of these radiations upon the respiratory process, and further investigations of the effects on growth are being made. Other respirational studies are also in progress. A very effective glass electrode has been set up for the study of H-ions and oxidation-reduction potentials in plant materials and processes. The possible relationship between certain stimulative effects of ultra-violet light upon plants and vitamin production is being investigated. An invitation paper on "Growth as a Criterion of Physiologic Response to Radiations" was presented in the special radiations program of the American Society of Plant Physiologists at its summer meeting in Chicago. The supervision of the introductory course in botany, together with the conducting of elementary and advanced courses, and a seminar in physiology and the directing of the studies of the graduate students in this field have been continued as usual.

Dr. Robert E. Woodson, Jr., Research Assistant to the Garden and Instructor in the Henry Shaw School of Botany of Washington University, has been in charge of the courses in elementary botany and has conducted courses in elementary plant morphology, plant anatomy, and microtechnique. He has continued his taxonomic studies in the families Apocynaceae and Asclepiadaceae, as well as research in the

morphology and anatomy of the stipules and stipular vestiges of the Contortae and the floral anatomy of the Apocynaceae, and the comparative morphology of Grisebachiella. Published articles include: "Apocynaceae" in H. A. Gleason and A. C. Smith, "Plantae Krukovianae". (Bull. Torrey Bot. Club **60**: 392. 1933); "Studies in the Apocynaceae, IV. The American Genera of Echitoideae." (Ann. Mo. Bot. Gard. **20**: 605-790. 1933); and (with George H. Pring) "A New Yellow Nymphaea from Tropical Africa." (Ann. Mo. Bot. Gard. **20**: 1-6. 1933).

Dr. Morris Moore and Dr. F. Lyle Wynd have assisted in the research work of Dr. Reynolds and Dr. Dodge, by means of grants from the Science Research Fund provided by the Rockefeller Foundation.

Graduates and Fellows. — The following appointments were made in the Henry Shaw School of Botany for the year 1933-34:

Assistants in Botany (half-time graduate students): Joseph C. Moore, B.S., Alabama Polytechnic Institute, Auburn, Ala. (Plant Physiology); Mary Elizabeth Pinkerton, B.S., University of Nebraska, Lincoln, Nebr., M.S., Washington University (Mycology and Physiology); Ward McClintic Sharp, A.B. and M.S., University of West Virginia, Morgantown, W. Va. (Taxonomy and Morphology).

Washington University Fellowship: Louis Otho Williams, A.B. and M.S., University of Wyoming, Laramie, Wyo. (Plant Anatomy and Taxonomy).

Jessie R. Barr Fellowship, Washington University: Gladys Elizabeth Baker, A. B., University of Iowa, Iowa City, Ia. (Mycology).

Washington University Van Blarcom Scholarship: Mary Maxine Larisey, A.B., Washington University (Taxonomy and Morphology).

Special Research Fellowship, American Creosoting Company: Earl Esco Berkley, A. B., University of West Virginia, Morgantown, W. Va., M.S. and Ph.D., Washington University.

Independent Students: Ruth Vera Cornelius, A.B. and M.S., Washington University (Taxonomy and Morphol-

ogy); Noel Moore Ferguson, B.S., St. Louis College of Pharmacy (Physiology); George Bippus Happ, B.S., Cornell University, Ithaca, N. Y. (Taxonomy); John Adam Moore, B.S., Butler University, Indianapolis, Ind., M.S., State College of Washington, Pullman, Wash. (Plant Anatomy and Taxonomy).

Degrees.—The following graduate students in the Henry Shaw School of Botany received advanced degrees at the Washington University commencement, June 6, 1933: Doctors of Philosophy—Earl Esco Berkley, Josephine Darlington, George Jones Goodman, Morris Moore, Julian Alfred Steyermark, Frederick Lyle Wynd; Master of Science—Ruth Vera Cornelius.

Apprenticeships. — The apprenticeship system now in vogue is a continuation of the "instruction to gardeners" provided for by Mr. Shaw and inaugurated forty years ago. Of the various methods tried this has proved to be most satisfactory, since it meets a demand not usually provided for by more technical instruction, concerned more with theory rather than actual practice.

Apprentices now enrolled are: Paul Allen, A. A. Knoll, L. Rubinstein, and Wilbert Quest. O. G. Haas graduated during the year and received the certificate for satisfactory completion of the work. Two special apprentices, J. W. Burton and George D. Pring, taking only a part of the training, left in the fall of this year.

As in previous years, the course in gardening for amateurs was given from January to April. Sixty-three registered for this course. Because of the demand for work of a more advanced character, a second course has been planned and announced for the year 1934. A new course in botany and another in floral design were given to the Garden apprentices, and the facilities of the experimental greenhouse, with certain assistance, were made available to the members of the St. Louis Garden Club investigating the effect of various essentials of plant food and fertilizers. At the request of the Council of the Girl Scouts in St. Louis, a short course on trees was given to about twenty-five scouts and leaders, an outline of which is given below:

The parts of a tree:

1. The cells.
2. The roots.
   a. Main roots.
   b. Lateral roots.
   c. Root hairs.
3. The stem.
   a. Trunk, branches, and twigs.
   b. Woody cylinder.
   c. Bark.
4. The buds.
5. The leaves.
6. The flowers.
7. The seed.

The life history and processes of trees:

1. The life history of trees.
2. Life processes of trees.
   a. Functions of the roots.
      (1) Anchorage, (2) Absorption of water and raw plant food elements, (3) Storage, (4) Propagation.
   b. Functions of stems.
      (1) Support, (2) Conduction, (3) Storage, (4) Food manufacture.
   c. Functions of buds.
      (1) Growth, (2) Production of leaves and flowers, (3) Propagation.
   d. Functions of leaves.
      (1) Manufacture of plant food, (2) Transpiration, (3) Respiration.
   e. Functions of flowers.
      (1) Attracting insects, (2) Production of seed and fruit.
   f. Function of seed.
      Production of new plant.

How to estimate the age of trees:

1. Approximate estimation by diameter of tree.
2. Growth of twigs.
3. Counting annual rings in trunk of tree.

Identification of trees and shrubs when in leaf.
Identification of trees and shrubs from bark, buds, and leaf scars.
How to prune trees and repair injuries.
The protection of trees and shrubs against insects and diseases.
Practical demonstration of tree planting.
Use of trees for small gardens, school yards and streets.
Economic uses of wood.

Published Articles.—

Allen, Caroline K. A Monograph of the American Species of the Genus Halenia. Ann. Mo. Bot. Gard. **20**: 119-222. 1933.

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Beilmann, A. P. When is the Best Time to Prune a Tree? (Maples). Mo. Bot. Gard. Bull. **21**: 61-75. April, 1933.

Berkley, Dorothy Megowen and Earl E. Berkley. Super Optimal and Thermal Death Temperatures of the Cotton Plant as Affected by Variations in Relative Humidity. Ann. Mo. Bot. Gard. **20**: 583-604. 1933.

Cutak, Ladislaus. Cacti and Their Culture. Mo. Bot. Gard. Bull. **21**: 81-83. May, 1933.

Cutak, Ladislaus. Carrion Flowers. Mo. Bot. Gard. Bull. **21**: 134-136. November, 1933.

Cutak, Ladislaus. Ceropegias. Mo. Bot. Gard. Bull. **21**: 95-96. June, 1933.

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Cutak, Ladislaus. Succulent House Reopens in the St. Louis Botanic Garden. Desert **4**: 138. 1933.

Cutak, Ladislaus. Winter Care of Cacti. Mo. Bot. Gard. Bull. **21**: 107-108. September, 1933.

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Dodge, C. W. Roland Thaxter. Ann. Crypt. Exot. **6**: 1-12. *1 pl.* 1933.

Fairburn, David C. Dry Sand Treatment for Preserving Flowers. Mo. Bot. Gard. Bull. **21**: 105-107. September, 1933. (Reprinted in Horticulture, November, 1933, and Garden Digest, December, 1933, and St. Louis Post-Dispatch, November 9, 1933.)

Jensen, L. P. Identification of Woody Plants in Winter. Parks and Recreation **16**[5]: 210-211. 1933.

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La Garde, Roland V. Plants that Produce Light. Mo. Bot. Gard. Bull. **21**: 42-46. February, 1933.

Moore, John Adam. The Flora of Postage Stamps. Mo. Bot. Gard. Bull. **21**: 122-125. October, 1933.

Moore, John Adam. Remarkable Aerial Roots of a Tropical Grape Vine. Mo. Bot. Gard. Bull. **21**: 139-140. December, 1933.

Moore, John Adam, with Steyermark, Julian A. Report of a Botanical Expedition into the Mountains of Western Texas. Ann. Mo. Bot. Gard. **20**: 791-806. 1933.

Moore, Morris. Blastomycosis: Report of a Case, with a Study of an Etiologic Factor and a Classification of the Organism. Ann. Mo. Bot. Gard. **20**: 79-118. 1933.

Moore, Morris. A Neutral (?) Strain of *Mucor sphaerosporus* from Missouri. Ann. Mo. Bot. Gard. **20**: 469. 1933.

Moore, Morris. A Study of *Endomyces capsulatus* Rewbridge, Dodge and Ayres: A Causative Agent of Fatal Cerebrospinal Meningitis. Ann. Mo. Bot. Gard. **20**: 471-568. 1933.

Perry, Lily M. A Revision of the North American Species of Verbena. Ann. Mo. Bot. Gard. **20**: 236-362. 1933.

Pinkerton, M. Elizabeth. Ferns and Fern Allies of Missouri. Ann. Mo. Bot. Gard. **20**: 45-78. 1933.

Pring, George H. Collection of Water-lilies. New York Times, July 25, 1933.

Pring, George H. Curious Orchids in the Garden Collection. Mo. Bot. Gard. Bull. **21**: 96-99. June, 1933.

Pring, George H. *Dendrobium superbiens,* a Natural Hybrid *(D. Phalaenopsis* × *D. undulatum)*. Mo. Bot. Gard. Bull. **21**: 142-144. December, 1933.

Pring, George H. *Grammatophyllum multiflorum.* Mo. Bot. Gard. Bull. **21**: 109-110. September, 1933.

Pring, George H. New or Noteworthy Plants for St. Louis. I. × *Crinodonna Corsii (Amarcrinum Howardii),* II. *Tithonia speciosa* (Showy Mexican Sunflower). Mo. Bot. Gard. Bull. **21**: 37-41. February, 1933.

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Pring, George H. and Robert E. Woodson, Jr. A New Yellow Nymphaea from Tropical Africa. Ann. Mo. Bot. Gard. **20**: 1-6. 1933.

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Steyermark, Julian A. and John Adam Moore. Report of a Botanical Expedition into the Mountains of Western Texas. Ann. Mo. Bot. Gard. **20**: 791-806. 1933.

Steyermark, Julian A. and E. J. Palmer. The Family Isoetaceae in Missouri. Am. Fern Jour. **23**: 65-66. 1933.

Woodson, Robert E., Jr. Apocynaceae. In Gleason and Smith's Plantae Krukovianae. Bull. Torrey Bot. Club **60**: 392. 1933.

Woodson, Robert E., Jr. Studies in the Apocynaceae. IV. The American Genera of Echitoideae. Ann. Mo. Bot. Gard. **20**: 605-790. 1933.

Woodson, Robert E. Jr., with George H. Pring. A New Yellow Nymphaea from Tropical Africa. Ann. Mo. Bot. Gard. **20**: 1-6. 1933.

Wynd, F. Lyle. Nutrient Solutions for Orchids. Ann. Mo. Bot. Gard. **20**: 363-372. 1933.

Wynd, F. Lyle. The Sensitivity of Orchid Seedlings to Nutritional Ions. Ann. Mo. Bot. Gard. **20**: 223-237. 1933.

Wynd, F. Lyle. Sources of Carbohydrate for Germination and Growth of Orchid Seedlings. Ann. Mo. Bot. Gard. **20**: 569-581. 1933.

Scientific and Popular Lectures.—

A. P. Beilmann, Arboriculturist to the Garden: May 16, Garden Club of St. Louis, "The Care of Trees—Pruning and Fertilization"; December 13, Art Section of the Wednesday Club, "Unusual Flowers of Our Native Trees."

Carroll W. Dodge, Mycologist to the Garden: February 22, Pilgrim Congregational Church, "Recent Literary and Artistic Trends in Costa Rica."

D. C. Fairburn: April 17, Parent-Teacher Association of the Valley School, Maplewood, Mo., "Home Gardening"; December 1, St. Louis Horticultural Society, "The Gladiolus."

J. M. Greenman, Curator of the Herbarium: May 5, Illinois Academy of Science, at East St. Louis, "The Baptisias of the Mississippi Valley."

L. P. Jensen, Manager of the Arboretum: January 7, Greater St. Louis Association of Gardeners, at the Kirkwood High School, "How to Plant the Home Grounds"; January 21, students of the Washington, Mo., High School, "Conservation of Native Plants"; March 6, Gray Summit Garden Club, "The History of Landscape Gardening"; April 7, at Tree Planting and Arbor Day celebration at Gray Summit School, Gray Summit, Mo., "The Significance of Arbor Day"; April 19, at tree-planting demonstration at high-school grounds, Washington, Mo., "How to Plant and Care for Trees"; May 1, P. E. O. of Washington, Mo., "Your Garden and Mine"; May 7, Garden Club of Gray Summit, "New and Better Shrubs for Your Garden"; September 28, Gray Summit Home Economics Club, at Purina Farms, "How to Plant the Home Grounds"; October 7, Gray Summit Garden Club, "Observations on Gardening in Chicago and Milwaukee"; October 10, Garden Club of Sullivan, Mo., "Garden Club Activities"; October 14, St. Louis Wild Flower Club, "Regional Planning"; November 3, St. Louis Horticultural Society, "Highway Beautification"; November 22, Watson-Antire Regionway Improvement Association, at Valley Park, "Roadside Planting and Improvement"; December 4, Garden Club of Gray Summit, "The History of Landscape Gardening."

Paul A. Kohl, Floriculturist to the Garden: April 27,

Child Conservation Conference at the Village Trading Post, "The Planting of Seeds."

Mrs. Katherine H. Leigh, Assistant to the Director: January 9, Webster Groves Home Garden Club, "The Making of Bubble Bouquets."

George T. Moore, Director of the Garden: January 24, at the Delmar Baptist Church, "Henry Shaw and His Garden"; January 31, tenth Annual Florists' Week, meeting of the Illinois State Florists' Association, University of Illinois, "Plant Life"; February 8, St. Louis Colloid Medical Club, at Forest Park Hotel, "The Plant Commonwealth"; February 17, Civitan Club, at Hotel Statler, "The National Flower Show"; March 2, banquet of the North-Central States Entomologists' Conference, Hotel Statler, "Some Little-Known Plant Activities"; March 20, at St. Stephen's House, "Henry Shaw and His Garden"; March 28, Society of American Florists, at Hotel Chase, moving pictures of "Plant Life"; April 19, Business Women's Club of St. John's Methodist Church, "Henry Shaw and His Garden"; April 27, Gamma Alpha Fraternity, University of Missouri, "Some Inside Facts about Plants"; June 1, Supervisors of St. Luke's Hospital, "The Missouri Botanical Garden"; December 7, Sorosis Club of Greenville, Ohio, "Some Inside Facts about Trees."

G. H. Pring, Superintendent of the Garden: January 28, afternoon, Webster Groves Home Garden Club, "The National Flower Show"; January 28, evening, St. Louis League for the Hard of Hearing, "What to Plant in City Gardens"; February 2, at the tenth Annual Florists' Week, meeting of the Illinois State Florists' Association, University of Illinois, Urbana, "Water-lilies and Water Gardens"; February 17, Gavel Club of St. Louis and St. Louis County, "How to Take Advantage of Arbor Day"; February 22, O'Fallon Woman's Club, O'Fallon, Mo., "What to Plant in Your Garden"; February 27, Florists' Telegraph Delivery Association, Congress Hotel, "Controlling Flowering Plants for the National Flower Show"; February 28, The X Club, "Arbor Day and the National Flower Show"; March 7, senior students of Cleveland High School, "Advantages of Floriculture as a Profession"; March 13, afternoon, 20th Century Club, Jefferson Memorial, March 13, evening, St. Clair Garden Club, East St. Louis, "The National Flower Show"; March

14, Carondelet Improvement Association, Carondelet Branch Library, "St. Louis Gardens"; March 19, radio talk over Station KSD, "Changing Winter into Summer at the National Flower and Garden Show"; April 5, Wednesday Club of East St. Louis, "Planting City Gardens"; April 13, luncheon at Young Men's Christian Association, "The Romance of Our Native Flora"; April 18, Holly Hills Improvement Association, "How to Plant a City Garden"; April 20, Carlinville Women's Club, Carlinville, Ill., "Home Gardens"; April 26, students of Hosmer Hall, "Spring Flowers"; April 26, Rotary Club of Clayton, "Plant Exploration"; April 28, Child Conservation Conference at the Village Trading Post, "Spring Planting in the Garden"; May 2, Highland Woman's Club, Highland, Ill., "Water-lilies"; May 5, St. Louis Horticultural Society, "What to Plant in the Garden"; May 8, St. Clair Garden Club, East St. Louis, Ill.; "City Gardens"; May 11, Adolphus Busch School Parent-Teacher Association, "How to Plant a City Garden"; May 13, Home Economics and Arts Club, "New or Noteworthy Plants"; June 2, St. Louis Horticultural Society, "Water-lilies: Cultivation and Breeding"; June 7, noon, Scottish Rite Woman's Club, "Orchids"; June 7, at 8 o'clock, Boulevard Heights Improvement Association, "St. Louis Gardens"; June 21, Valley Park Lions' Club, "Jungle Experiences"; July 5, South Side Optimists' Club, "Optimistic Plants"; October 9, Caledonian Society, at the Hamilton Hotel, "Orchid Exploration"; October 20, Town Club of St. Louis, "The Lost Yellow Water-lily as a Factor in Breeding"; November 1, "Indian Guides" of the St. Louis Y. M. C. A., "Orchid Exploration"; November 6, Ladies Florists' Club of St. Louis, "The Value of Orchids in Floral Design"; November 21, Midland Valley Garden Club, "Gardening as a Hobby"; November 23, Missouri Federation of Garden Clubs, in the Garden lecture room, "The Evolution of the Chrysanthemum"; November 28, Rose Hill Lodge, "Orchid Exploration in the Andes of Colombia"; December 1, Osage Garden Club, "Winter Protection in the Garden."

Ernest S. Reynolds, Physiologist to the Garden: June 22, summer meetings Botanical Society of America, Chicago, "Growth as a Criterion of Physiologic Response to Radiations."

HERBARIUM

Growth and continued progress have been the outstanding features of the herbarium during the year 1933. Many new and important collections have been acquired.

The largest single collection obtained is the private herbarium of the late Honorable Joseph Richmond Churchill, who for many years was a distinguished jurist of Boston, Massachusetts, but whose avocation was the study of plants. The Churchill herbarium—a bequest—is estimated to contain between 12,000 and 15,000 specimens representing primarily the flora of eastern North America. Since practically all the specimens were collected and studied by Judge Churchill himself and the identifications either verified by him or by professional botanists at the Gray Herbarium of Harvard University, the Churchill collection constitutes a highly valued addition to the Missouri Botanical Garden Herbarium.

Another outstanding and important acquisition is the lichen herbarium of the late A. de Crozals, of France. This collection was obtained by purchase; it contains upwards of 4,000 specimens and is very rich in Collemaceae and in the Mediterranean lichen-flora, including a large series of specimens from Corsica. Since these regions are very poorly represented in American herbaria, it makes a welcome addition to the Garden collections. Besides the types of de Crozals' species, the herbarium contains much material which has been determined critically by other lichenologists, notably Bouly de Lesdain.

Further noteworthy accessions are the following: Paul Aellen, 189 plants of Switzerland and 150 plants of Corsica; Paul Allen, 176 plants of Colorado; Arnold Arboretum, 235 plants of eastern and central United States; Botanical Institute, University of Masaryk, Brno, 100 plants of Moravia; Botanical Museum, University of Cluj, 177 plants of Roumania; W. E. Broadway, 365 plants of Trinidad; B. F. Bush, 476 plants chiefly from Missouri; California Academy of Sciences, 249 plants mostly from California; C. Conzatti, 121 plants of Mexico; F. M. Cota, 57 lichens of southern California and Lower California; Delzie Demaree, 258 plants

of California and 79 plants of Florida; C. W. Dodge, 407 mostly nonvascular plants of Central America, Quebec, and British Columbia; J. A. Drushel, 145 plants of eastern United States; A. D. E. Elmer, 423 plants of the Philippine Islands; Field Museum of Natural History, 154 plants mainly from South America; H. A. Gleason, 270 plants of Brazil; R. M. Harper, 106 plants of southeastern United States; B. F. Harrison, 246 plants of Utah; Herbarium Horti Botanici Universitatis Asiae Mediae, 500 plants of central Asia; G. Herter, 153 plants of Uruguay; M. E. Jones, 437 plants of Mexico; J. H. Kellogg, 50 plants of Missouri; E. P. Killip, 731 plants of Peru; A. E. Lawrance, 663 plants of Colombia, South America; R. La Garde, 66 plants of Bohemia; Lingnan University, 559 plants of China; Maude Lodewyks, 58 plants of Missouri; C. L. Lundell, 323 plants of the Yucatan Peninsula; New York State College of Agriculture, by K. M. Wiegand, 625 plants of New York; Lily M. Perry, 77 plants of Georgia; A. Pilat, 100 fungi of Czechoslovakia; M. P. Porsild, 225 plants of Greenland; Edith A. Purer, 111 plants of California; G. Samuelsson, 610 plants of Brazil and Argentina; W. A. Schipp, 266 plants of British Honduras; B. Shimek, 71 plants of Iowa; J. A. Stevenson, 184 specimens of Coleosporium of the United States; R. R. Stewart, 700 plants from the Himalayan region of India; J. A. Steyermark, 386 plants mostly from Missouri; J. William Thompson, 858 plants of Washington; U. S. National Herbarium, 146 plants chiefly from southern United States and Tropical America; University of California, 165 plants mainly from California and Alaska; University of Michigan, 112 plants from Central America and Sumatra; University of Missouri, 185 plants of Missouri; University of Wisconsin, 320 plants of Wisconsin; University of Wyoming, 389 plants of Wyoming; E. J. Valeur, 150 plants of Santo Domingo; Fr. Verdoorn, 100 hepatics; Th. Oswald Weigel, 250 plants of Bolivia, the French Antilles, and other regions; J. J. White, 126 non-vascular plants of British Honduras; L. O. Williams, 437 plants of Wyoming. In addition to these, numerous smaller accessions have been received, all of which have been recorded in the current issues of the BULLETIN for 1933.

This enumeration shows that the additions, which have been made to the herbarium during the year, have maintained an equable increase in the representation of the flora of different parts of the world; and at the same time they have augmented to a marked degree particular groups of plants. Thus, the usefulness of the herbarium for floristic studies and monographic research has been greatly enhanced.

Mounting and Inserting of Specimens.—The mounting of new material has continued uninterruptedly throughout the year; and 16,753 specimens have been mounted and incorporated in the organized part of the herbarium.

Exchanges. — Approximately 2,000 duplicate herbarium specimens have been distributed to correspondents during the year. Although this number is relatively small, yet substantial progress has been made in working over old material which has been in storage for several years, particularly the collections of the late Rev. John Davis. Duplicate sets of plants from this herbarium will soon be sent to correspondents and to institutions with which the Garden maintains an exchange account.

Insertion and Reorganization of Specimens.—The insertion of new material, as in previous years, has followed closely the work of mounting. Progress has been made in the reorganization of specimens of several families. This very necessary work has occupied much of the time of the small herbarium staff. In this work some of the more advanced graduate students in taxonomy have rendered helpful assistance. Several special groups of plants have been carefully studied and have served as the basis for floristic and monographic research. The results of some of this work have been incorporated in publications mentioned elsewhere in this report.

Parts of the herbarium became so crowded during the year from the interpolation of new material that it was necessary in the course of the past summer to shift about eighty-five per cent of the entire collection. This shift and the rehabilitation for temporary use of a few old discarded wooden cases have relieved the extreme congestion and permit the incorpo-

ration of the new material on hand; but the installation of additional new steel cases to adequately care for the increased growth is at present the most pressing need of the herbarium.

Field Work.—While no extended expeditions have been made during the year, yet local field work has been pursued to a limited extent. Many noteworthy additions to the herbarium have been made by members of the staff, graduate students, and friends interested in our local flora.

Use of the Herbarium.—The number of botanists making use of the herbarium has increased considerably over that of any one previous year. Several loans of herbarium specimens for critical study have been made to specialists residing in different parts of the country. Likewise, several loans of specimens for study by members of the staff or for taxonomic students in the Henry Shaw School of Botany have been received from other institutions. While the matter of keeping a detailed and accurate record of loans received and of loans made is becoming increasingly time-consuming, yet little progress in taxonomic research could be made without some co-operative plan of inter-institutional loans.

Statistical Summary (for the year ending December 31, 1933):

Number of specimens acquired on new accessions:		
By purchase	13,972	
By gift	14,071	
By exchange	4,626	
Total	32,669	valued at $4,083.63
Number of specimens mounted and incorporated	16,753	valued at 3,350.60
Number of specimens discarded from the herbarium	7	without value
Number of specimens in organized herbarium	1,047,964	valued at $171,123.55
Number of specimens in unorganized herbarium	101,525	valued at 10,550.40
Wood specimens, etc., in herbarium		valued at 280.00
Microscope slides		valued at 400.00
Total valuation		$182,353.95

LIBRARY AND PUBLICATIONS

No serious curtailment in the library and publications has been necessary during 1933. A number of serials already in local libraries were discontinued, but all important new publications have been purchased and several valuable old ones. With the decrease in value of the dollar the discontinuance of the expensive German periodicals was contemplated, but since the libraries throughout the country have forced the publishers to reduce their prices one-half, these may be maintained in the future. Among the noteworthy book acquisitions were three volumes of Jacquin's "Hortus Vindobonensis," published in 1770-76. This is a rare and valuable work for which the library has been searching for some time, and last year it was advertised in a catalogue at a price sufficiently low to make its purchase possible. Another important purchase was through Gurney Wilson, the Garden's European representative, of the first edition of Linnaeus' "Genera Plantarum," 1737, a book often needed in working up the history of the various genera. The copy was complete except for a special plate of drawings contained in some editions, and a photostatic reproduction of that from the British Museum copy was obtained. From Mr. Wilson also there have been received valuable additions to the collection of seed catalogues, as well as plates, and original drawings of orchids.

A notable accession during 1933 was the library of the late J. R. Churchill bequeathed to the Garden. This consisted of 170 books and 176 pamphlets. While many of them were duplicates they were publications of which two copies could well be utilized, such as Gray's "Synoptical Flora," a full set of the "Contributions of the Gray Herbarium," etc. The collection is unusually rich in writings on local floras, especially of New England, and included two copies of "Betula," a publication contained in only two other libraries in the country. There was also a Linnaean work not previously contained in the Garden library, Linnè, "A general system of nature, etc." translated from Gmelin's last edition by W. Turton.

The gift by Dr. von Schrenk, of bulletins and reprints from his library, has been organized and catalogued and was found to contain many missing numbers of serials, also many bulletins which could be used as separates.

During the year the 1,400 pre-Linnaean and Linnaean books, which constitute the oldest and most unique collection in the library, were inventoried, cleaned, and oiled. Since most of them were bound in calf, vellum, or parchment, the process was necessarily a most careful one. The books were first cleaned with absorene, then washed with saddle-soap. The parchment bindings were rubbed with a mixture containing alcohol, glycerin, and distilled water, and the leather ones were treated with a preparation recommended by the Library of Congress. Several months were required to complete the work, but the improved condition of the books amply compensates for the labor involved. In February the two bookbinders, who visit the Garden library annually, repaired or oiled 184 books.

In July about 1,200 reprints of the ANNALS were mailed to 225 botanists in this country and abroad, in exchange for their publications.

Use of the Library.—In addition to the staff and students of the Shaw School of Botany, the following botanists have made use of the resources of the library during the year: Dr. George M. and Dr. Joanne Karrer Armstrong, the former, head, department of botany and bacteriology, Clemson College, South Carolina; Dr. Dow V. Baxter, assistant professor of forest pathology, School of Forestry, University of Michigan; Mr. Chunling Chung, of Canton Christian College, China; Mr. Ora M. Clark, of Bristol, Oklahoma; Dr. Delzie Demaree, formerly assistant professor of botany, University of Arkansas, Fayetteville; Dr. Ethel Eltinge, instructor in botany, Mt. Holyoke College, South Hadley, Mass.; Dr. Harry J. Fuller, instructor in botany, University of Illinois, Urbana; Dr. George J. Goodman, instructor in botany, University of Oklahoma, Norman; Mr. Aaron Kipnes, graduate student from the University of Iowa, Iowa City; Miss Julia K. Lawrence, instructor in botany, Vassar College, Poughkeepsie, N. Y.; Mr. Fritz Leissler, landscape gardener of the Seattle Park Department; Dr. Mildred

E. Mathias, research associate, New York Botanical Garden; Prof. A. C. Noe, associate professor of palaeobotany, University of Chicago; Mr. E. J. Palmer, collector, Arnold Arboretum, Jamaica Plain, Mass.; Mrs. Ellen Rooksby, editor "Desert Magazine," Pasadena; Dr. H. R. Rosen, professor of plant pathology, University of Arkansas, Fayetteville; Dr. Albert C. Saeger, head, department of biology, Junior College of Kansas City; Dr. E. E. Sherff, head, department of science, Chicago Normal College, Chicago; Dr. Bohumil Shimek, professor emeritus of botany, University of Iowa, Iowa City; Dr. George H. Smith, of Indianapolis, Indiana; Dr. E. R. Spencer, professor of botany, McKendree College, Lebanon, Ill.; Dr. A. Stark, research assistant, Iowa State College, Ames; Dr. Julian A. Steyermark, formerly Rufus J. Lackland Research Fellow, Shaw School of Botany of Washington University; Miss Eula Whitehouse, instructor in botany, University of Texas, Austin; Dr. E. J. Wilde, professor of ornamental horticulture, Pennsylvania State College, State College, Penn.

Prof. H. W. Rickett, associate professor of botany, University of Missouri, and Miss Esther Adams, instructor in biological sciences, Moberly Junior High School, Moberly, Mo., accompanied their classes in botany on a day's tour of the Garden library and herbarium.

Out-of-town botanists from 21 institutions borrowed 97 books on the interlibrary-loan plan during the year.

Garden Publications.—Volume XX of the ANNALS OF THE MISSOURI BOTANICAL GARDEN, consisting of 817 pages, 23 plates, and 43 text-figures, was published during the year. The volume is about twice the normal size, since it contains three of the doctoral dissertations, a paper by Dr. Dodge on his scientific explorations in Costa Rica, and the fourth installment of Woodson's "Studies in the Apocynaceae." The monthly BULLETIN for 1933 (Vol. XXI) was also completed and comprises 158 pages and 42 plates. The cash receipts during the year from the sale of ANNALS, BULLETINS, reprints, Books of Views, etc., was $1,048.00. Both ANNALS and BULLETINS are sent in exchange for other publications, 420 foreign and 125 domestic institutions exchanging their

publications with the ANNALS, and 47 foreign and 48 domestic institutions being on the BULLETIN exchange list.

ARTICLES MENTIONING THE MISSOURI BOTANICAL GARDEN, OR REPRINTS FROM ARTICLES APPEARING IN THE MISSOURI BOTANICAL GARDEN BULLETIN, EXCLUSIVE OF NEWSPAPER PUBLICITY, DURING 1933

American Home **9**:78. January, 1933. Picture of "before" and "after" garden at the Garden, illustrating article "Garden Facts and Fancies"—discusses work with water-lilies.

American Home **9**:306. May, 1933. Extract and plates from article "Keeping the Water-lily Awake" in Mo. Bot. Gard. Bull. **20**:99-101. 1932.

American Orchid Society Bulletin **1**:79-81. December, 1932. "Henry Shaw—1800-1889."

American Orchid Society Bulletin **1**:102-107. March, 1933. "Latin America and the Queen of Flowers," by Dr. George T. Moore.

American Orchid Society Bulletin **2**:29-31. September, 1933. "Botanical Orchids." From Mo. Bot. Gard. Bull. **21**:96-99. 1933.

Desert **5**:102. November, 1933. "What's in a Name?"—brief account of Dr. Engelmann and his connection with the Garden and friendship with Henry Shaw.

Florists' Exchange **81**:9, 13-14. April, 1933. "Fourteenth National Flower and Garden Show." Contains illustration of Garden's exhibit at flower show.

Florists' Exchange **81**:19. May 6, 1933. St. Louis floral news and the Garden; three days' course in practical gardening at Village Trading Post.

Florists' Review **72**:11. July 13, 1933. "Tropical Lilies of Unusual Interest Produced by Hybridizers." Reprinted from Mo. Bot. Gard. Bull. **21**:49-54. 1933.

Garden Digest **5**:18,28. October, 1933. "Succulents from Seed in the Home." Reprinted from Mo. Bot. Gard. Bull. **21**:41-42. 1933.

Garden Digest **5**:14-16. December, 1933. "Dry Sand Treatment for Preserving Flowers." Reprinted from Mo. Bot. Gard. Bull. **21**:105-106. 1933.

Horticulture **11**:9-10. January, 1933. Illustration of Bubble Bouquets. Reprinted from Mo. Bot. Gard. Bull. **20**:87-89. 1932.

Horticulture **11**:364. November, 1933. Extract from "Dry Sand Treatment for Preserving Flowers" in Mo. Bot. Gard. Bull. **21**:105-106. 1933.

Modern Cemetery **43**:32-34. April, 1933. "Some Diseases of Elm Trees." Reprinted from Mo. Bot. Gard. Bull. **19**:61. 1932.

National Pharmacy Week Pamphlet. 1933. Article on "Celebration at Garden of First Recognized Use of Cinchona."

Park and Cemetery **42**:329-330. February, 1933. "Drouth and Winter Injury." Reprinted from Mo. Bot. Gard. Bull. **20**:80-82. 1932.

Public School News. March, 1933. "National Flower Show and the Missouri Botanical Garden."

Society American Florists and Ornamental Horticulturists, Fourteenth National Flower Show. 1933. 1. Article about Missouri Botanical Garden. 2. Exhibits of Garden at Show.

Southern Florist **34**:5-6, 17-18. February 24, 1933. "Water Lilies: Their Propagation and Culture." Reprinted from Mo. Bot. Gard. Bull. **21**:49-54. 1933.

Southern Florist **34**:7-8. March 24, 1933. Article about National Flower and Garden Show and Missouri Botanical Garden.

Southern Florist **35**:7. April 14, 1933. Garden exhibits, Garden luncheon, scientific exhibits, Manda memorial, described in article on Fourteenth National Flower and Garden Show.

Tropical Life **29**:226. November, 1933. "Dry Sand Treatment for Preserving Flowers." Abstract from Mo. Bot. Gard. Bull. **21**:105-106. 1933.

Tropical Life **29**:229. November, 1933. Note about importation of *Amorphophallus Titanum* to the Garden. Mo. Bot. Gard. Bull. **21**:2. 1933.

Wisconsin Horticulture **23**:186. March, 1933. "Let's Make Bubble Bouquets." Reprinted from Mo. Bot. Gard. Bull. **20**:87-89. 1932.

Wisconsin Horticulture **24**:90. December, 1933. "Dry Sand Treatment for Preserving Flowers." Reprinted from Mo. Bot. Gard. Bull. **21**:105-106. 1933.

New Accessions.—The following are some of the noteworthy accessions received by the library during the year: Abderhalden, Handbuch d. biologischen Arbeitsmethoden Abts. IX and XIII; Aichinger, Vegetationskunde der Karawanken (Pflanzensoziologie, vol. 2); L'Amateur d. Champignons—6 volumes; Bailey, The cultivated conifers in North America; Braun-Blanquet, Plant sociology (Translated and edited by Fuller and Conard); Bresadola, Funghi mangerecci e velenosi, vols. 1-2; Engler, Das Pflanzenreich, Heft 98f; Hoffmann, Icones analyticae fungorum Abb. u. Beschreib. v. Pilzen mit Rücks. auf Anatomie u. Entwickel-

ungsgeschichte; Hue, Lichenes morphologice et anatomice disposuit; Hue, Lichenes exotici a W. Nylander descript. et in Herb. Mus. Paris; Krenke, Busch, and Moritz, Wundkompensation, Transplantation und Chimären bei Pflanzen, (Monogr. a. d. Gesamtgebiet d. Phys. d. Pflanzen und der Tiere, vol. 29); Laurens, Physiological effects of radiant energy; Lindner, Mikroskopische und biologische Betreibskontrolle in den Gärungsgewerben, etc. 6th ed.; Linnaeus, Genera Plantarum. 1st edition; McDonald, Agricultural writers (1200-1800); Marloth, The Flora of South Africa. vol. 3, pts. 1-2; Osborn, Shrubs and trees for the garden; Ostenia (Ostenfestschrift); Rothamsted Memoirs, vols. 15-16; Schuchert and Dunbar, Text-book of geology. part 2; Small, Manual of the Southeastern Flora; Smith, G., Freshwater algae of the United States; Stebbing, The forests of India. 3 vols.; Sydow, Monographia Uredinearum. vol. 4; Union list of serials. final edition; Verdoorn, Manual of bryology; Wahlenberg, Flora carpatorum principalium. Göttingen, 1814; Wettstein, Handbuch der systematischen Botanik. vol. 1. 4th ed.

Statistical Information.—There have been donated to the library or received in exchange during the year 643 books valued at $1,667.81, and 1,333 pamphlets valued at $326.94. Two hundred and fifty-two books were bought at a cost of $2,168.95, and 178 pamphlets at a cost of $177.77. The library now contains 48,553 books and 74,246 pamphlets. There are 332 manuscripts valued at $1,621.80, and 1,007,086 index cards valued at $12,230.88. A total of 5,204 cards were added during the year, of which 1,090 were written by Garden employes, and 5,114 were purchased at a cost of $111.35. One hundred and seventy books were bound and 1,612 repaired or restored.

GEORGE T. MOORE,
Director.

STATISTICAL INFORMATION FOR DECEMBER, 1933

GARDEN ATTENDANCE:

Total number of visitors.....29,128

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought..... 20
Total number of books and pamphlets donated..... 118

PLANT ACCESSIONS:

Total number of seed packets donated..... 170

HERBARIUM ACCESSIONS:

By Purchase—

Broadway, W. E.—Plants of Trinidad..... 95
de Crozals, Mme. M.—Lichen herbarium of the late A. de Crozals..... 4,084
Lawrance, Alexander E. — Plants of Colombia, South America 120
Lundell, C. A.—Plants of the Yucatan Peninsula, collected by Percy Gentle..... 109
Samuelsson, Dr. G.—Plants of Brazil, collected by P. Dusén 113
Schipp, W. A.—Plants of British Honduras..... 77

By Gift—

Bakke, Professor A. L.—Plants of Iowa..... 2
Clemens, Mrs. M. S.—Fern from Borneo..... 1
Davis, Dr. J. J.—*Dilophospora geranii* Schroet. from Wisconsin 1
Goodman, Dr. George J.—*Ephedra* from Oklahoma..... 1
Steyermark, Dr. Julian A.—*Trichocolea tomentella* (Ehrh.) Dum. from Missouri..... 1
Williams, L. O.—Plants of Wyoming and Utah, collected by O. J. Murie..... 84

By Exchange—

California Academy of Sciences by John Thomas Howell —Plants of California, etc..... 209

Total 4,897

SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date to the death of Mr. Shaw, in 1889, the Garden was maintained under the personal direction of its founder, and, while virtually a private garden, it was, except at certain stated times, always open to the public. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was designated by Mr. Shaw as its official title and in his will or in any of his writings he specifically referred to it as the "Missouri Botanical Garden." By a provision of Mr. Shaw's will the Garden passed at his death into the hands of a Board of Trustees. The original members of the Board were designated in the will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will, the immediate direction of the Garden is vested in a Director, appointed by the Board of Trustees. The Garden receives no income from city or state, but is supported entirely from funds left by the founder.

The city Garden comprises 75 acres, where about 12,000 species of plants are growing. There is now in process of development a tract of land of over 1,500 acres outside the city limits which is to be devoted to (1) the propagation and growing of plants, trees, and shrubs, designed for showing either indoors or outside, at the city Garden, thus avoiding the existing difficulties of growing plants in the city atmosphere; (2) gradually establishing an arboretum as well as holding a certain area as a forest reservation, with the idea that possibly at some future time this may become the new botanical garden.

The Garden is open to the public every day in the year, except New Year's Day and Christmas—week days from 8:00 a. m. until one-half hour after sunset; Sundays from 10 a. m. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Place, on the Sarah car line (No. 42). Transfer south from all intersecting lines. The Garden may also be reached by Bus Route No. 12, to which all other motor-bus lines transfer.

STAFF
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Missouri Botanical Garden Bulletin

Vol. XXII FEBRUARY, 1934 No. 2

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ST. LOUIS, MO.
1934

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SPECIAL NUMBER ILLUSTRATED IN COLORS
TWENTY-FIVE CENTS

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OF THE MISSOURI BOTANICAL GARDEN

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NYMPHAEA BURTTII INTRODUCED FROM AFRICA, FLOWERED IN GREENHOUSE JULY 9, 1930

Missouri Botanical Garden Bulletin

Vol. XXII FEBRUARY, 1934 No. 2

HYBRID NYMPHAEAS

Interest in the growing of water-lilies is increasing among amateur and professional gardeners, and there is a constant demand for new forms and colors. Up to this date seventeen new hybrids and one new species of Nymphaea have been introduced from the Garden, which seem worthy of being propagated. While the work of hybridizing water-lilies at the Garden will probably be continued indefinitely it seems desirable at this time to give a resumè of the achievements of the last twenty years, and to include descriptions and colored illustrations of the Garden's introductions.

The most important achievement in hybridizing tropical day-blooming water-lilies up to the present time is the introduction of two new colors—white and yellow. A remarkable fact about the first white lily to be hybridized, *Nymphaea* "Mrs. George H. Pring," is that its parents were of a dominant blue color. *Nymphaea flavo-virens (gracilis),* of Mexico, the only pure white-flowered species, had been used in crossing with forms of *N. capensis zanzibariensis,* but the resulting progeny had always shown white recessive. Moreover, its offspring, *N.* "Stella Gurney," "Mrs. C. W. Ward," and "William Stone" (known in the trade as star lilies), have inherited the narrow stellate flowers of *N. gracilis.*

In 1915 experiments were started at the Garden, with the object of producing the much-needed albino hybrids comparable to present-day horticultural forms. The introduction of seeds of *Nymphaea ovalifolia* Conard, from Africa, by the Bureau of Plant Introduction, U. S. Department of Agriculture, and their successful germination by the late Mr. E. T. Harvey, of Cincinnati, gave the much-needed material to the hybridist. The species is a vigorous grower, producing large white flowers, tipped with blue, but with one defective feature—the small number of petals. *Nymphaea ovalifolia* was therefore crossed with the semi-double *N. castaliiflora.* The seeds of the hybrid germinated readily, and during the summer months produced the largest flowers of any of the Brachyceras group. This was *Nymphaea* "Mrs. Edwards Whitaker," with blue flowers which bleached to almost white with age. Using *N.* "Mrs. Edwards Whitaker" as a staminate parent and *N. ovalifolia* as a pistillate parent blue flowers resulted, but the reciprocal cross showed the white color dominant. One pure albino form showing the large Whitaker-shaped flowers and leaf characters was selected as the desired type. It was carefully self-pollinated during the summers of 1920 and 1921, and its offspring produced albino flowers. The finest flowers were again selected and self-pollinated, and again pure white flowers resulted but with an increase both in number and size of petals. By careful selection and self-pollination all pink and blue shades from the parent flowers were eliminated and the desired hybrid was obtained in 1922 ("Mrs. George H. Pring"), the white color being then fixed, provided of course that all foreign pollen was excluded.

Only two yellow tropical Nymphaeas have been previously described—*N. sulphurea* and *N. Stuhlmannii.* After a search of over ten years a seed-pod of what was presumed to be *Nymphaea Stuhlmannii* was obtained through the personal efforts of Mr. B. D. Burtt, Esq., botanist for the Tsetse Research Bureau, Kondoa, Tanganyika Territory. An excerpt from Mr. Burtt's notes is quoted.

"The seed was collected from plants growing in a seasonal rain-pond in the Sambala 'Mbuga' seasonal

swamp, the plants having spectacular yellow flowers 8 inches in diameter and sweet scented. The flowers float on the surface of the water and on examination were found to contain dead bees *(Apis melifera* [?]*)* that were imprisoned by the anthers over the stigmatic surface of the flowers. The plants were collected on May 19, 1929, the seed from the same locality on July 15, 1929. Other plants were collected March 16, 1929, from a seasonal rain-pond near Salia, Kondoa District. I have observed the plant in seasonal rain-ponds at Magungila, Wembare Steppe in 1928, also near Lilbilin, Massai Land, in 1927."

The single small seed-pod, in somewhat immature condition, was received at the Garden on September 19, 1929. It was immediately cleaned, and the many seeds planted in the greenhouse water-lily tanks. Three weeks later a single seed germinated from the lot, producing its first primrose-yellow flower on June 17, 1930. On July 30, the plant was removed from its pot and planted in the pond outdoors where it continued to bloom until frost. The plant proved to be a new species and was named *Nymphaea Burttii* in honor of its collector.

During 1930 upwards of eighty-six reciprocal pollinations were made with *Nymphaea Burttii,* resulting in a solitary reciprocal fertile cross between *N. Burttii* and *N.* "Independence" (of Tricker). The following season the seedlings showed the blue and pink color dominant, and viviparous habit and yellow color recessive. In the second generation the pale blue when selfed produced yellow as the dominant color, whereas the dark blue and pink selfs showed yellow again recessive. It is interesting to note that light blue was obtained through *N. Burttii* as the male parent which in the second generation brought yellow dominant, while with *N.* "Independence" as the male parent blue and pink were again dominant. In all the other pollinations blue and pink were dominant colors with yellow positively recessive, except when *N. Burttii* was pollinated with white in which case yellow was dominant. When crossed with *N.*"Mrs. George H. Pring," yellow was dominant, white, pink, and blue recessive, and

pollinations with *N. ovalifolia* resulted in yellow and blue being dominant, white and pink recessive. Yellow as a dominant factor was shown the following season when *N.* "Mrs. George H. Pring" was crossed with *N. Burttii,* the seedlings resembling *N. Burttii. Nymphaea* "Mrs. Edwards Whitaker" × *N. Burttii* showed pink as the recessive color, blue dominant, and yellow represented by a single yellow seedling.

Of the 246 pollinations with *N. Burttii* thousands of seedlings were grown. The results showed the same dominant and recessive characters, blue and pink being dominant except where white parents were used, in which case the dominant character was always yellow. Since space would not permit planting directly in the ponds, the seedlings were planted in small pots which were plunged in the soil in the display ponds. This method permits the hybridist to grow a greater quantity of material, especially in the second generation when the interesting color variations appear. When the seedlings were planted directly in the ponds, large tubers naturally developed which often are hard to perpetuate through the selected seedling. When kept in small pots, the tubers are small and more readily propagated. The following season propagated specimens were planted out in the ponds to obtain fully matured plants.

Amateur growers of water-lilies naturally prefer the viviparous type of hybrids, because the growths can be carried throughout the winter as stock for the following season. Many pollinations have been made with this type, resulting in noteworthy hybrids of yellow, white, pink, and campanula-blue, in the second generation. The viviparous character from the original species *N. micrantha,* according to experiments at the Garden, is generally recessive the first season.

In selecting the hybrids described, various factors have been tested, such as: color, size, number of petals, and the ability to be propagated from leaf or tubers. Experiments to date warrant introducing only eight new lilies selected from the 246 pollinations with the new yellow as a parent. Ridgway's color terminology in his "Color Standards and Nomenclature" has been used in the floral descriptions.

NYMPHAEA CROSSES

NAME	DATE
castaliiflora	1913
"Mrs. Edwards Whitaker"	1917
"General Pershing"	1917
"Mrs. Woodrow Wilson" var. *gigantea*	1918
"Henry Shaw"	1919
"Mrs. George H. Pring"	1922
"Edward C. Eliot"	1924
"Mrs. George C. Hitchcock"	1926
Burttii (introduced species)	1930
M. B. G. 2	1931
"Missouri"	1932
"St. Louis"	1932
M. B. G. 96	1933
M. B. G. 104 violet	1933
M. B. G. 104 pink	1933
M. B. G. 147	1933
M. B. G. 151	1933
M. B. G. 162	1933

BRACHYCERAS GROUP OF NYMPHAEAS

With the exception of "Mrs. George C. Hitchcock" and "Missouri," which belong to the Lotos, or night-blooming group of Nymphaeas, all the water-lilies described on the pages following are of the Brachyceras, or day-blooming, type. In this group the flowers open 5-6 successive days from 8 A. M. to 6 P. M. during August, and are fragrant. The peduncle is terete, rises 1-1½ feet above the water, and in cross-section shows 6-7 main air-canals, encircled by 10-17 smaller ones, these again surrounded by still smaller ones. There are always 4 sepals which are thick and fleshy in texture. The petals are generally elliptic, obtuse or acute, thick in texture except along the margins, in rows of three, becoming narrower and shorter toward those of the innermost row, which are narrowly oblong-elliptic, acute. The stamens are in several rows which become shorter and narrower toward the center, the filaments of the outer row conspicuously broader than the linear anthers. The stigma is slightly concave, exposed and receptive only the first day of opening. The second day it is covered by the crowded inflexed stamens

which become reflexed the fourth day, exposing the nectarless stigma.

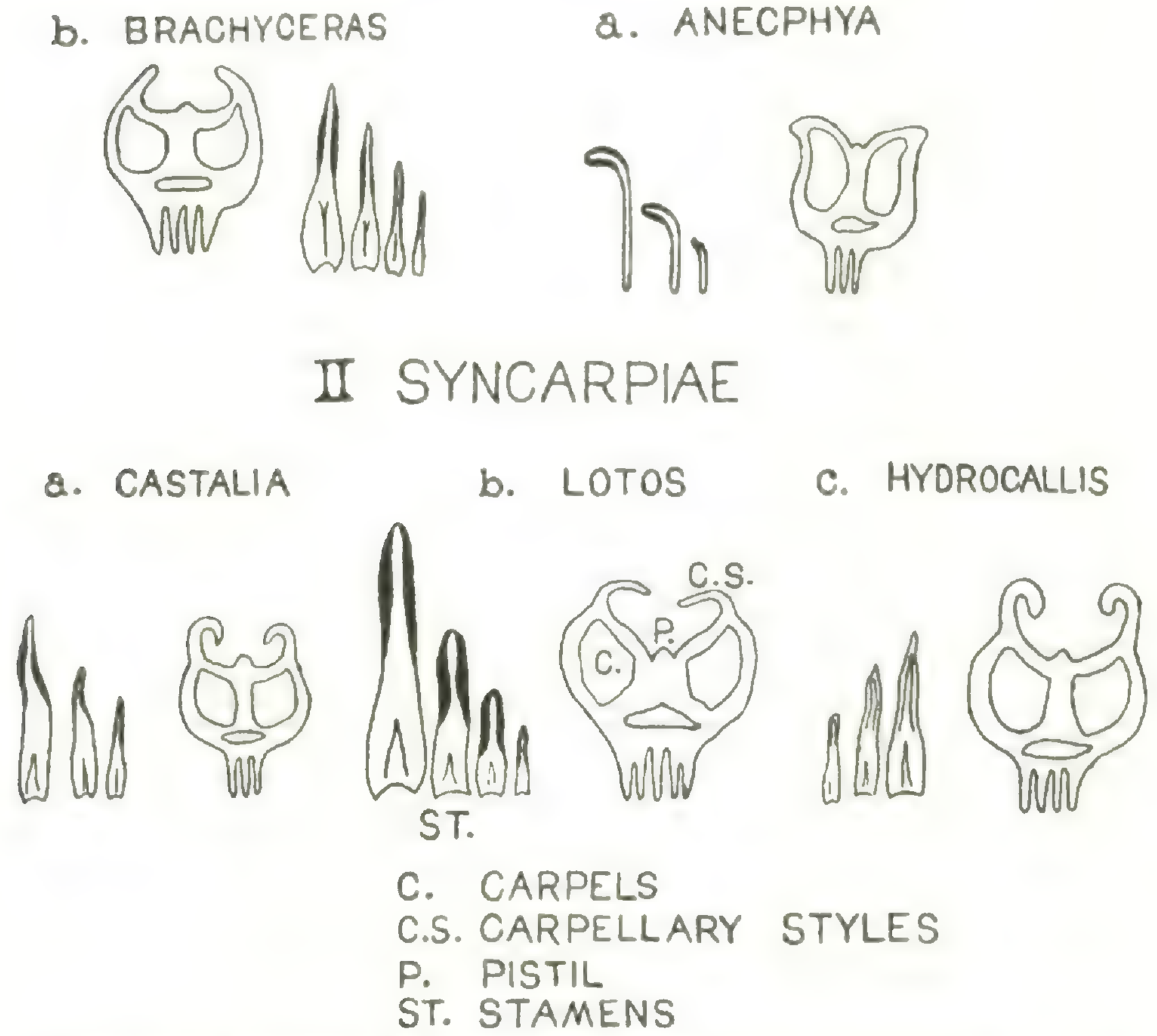


Diagram showing stamens and transverse sections of seed-pods in two groups and five sub-groups of Nymphaea. The stamens are distinguishing characters in the sub-groups.

LOTOS GROUP OF NYMPHAEAS

In this group the flowers are of nocturnal habit, opening from 7 P. M. to 11 A. M. The peduncle is as in the Brachyceras group. The 4 sepals are thick in texture, green and purplish-brown on the outer surface, with prominently raised veins of a lighter color. The petals are larger than in the Brachyceras group, and the colors are either white

or rhodonite-pink, yellow and blue not being represented. The stamens are ligulate, the anthers gradually tapering to a widened filament. The stigma is slightly concave, exposed and receptive only the first day of opening. The leaves offer two distinctive characters—the prominent venation beneath and the subspinose-dentate margin.

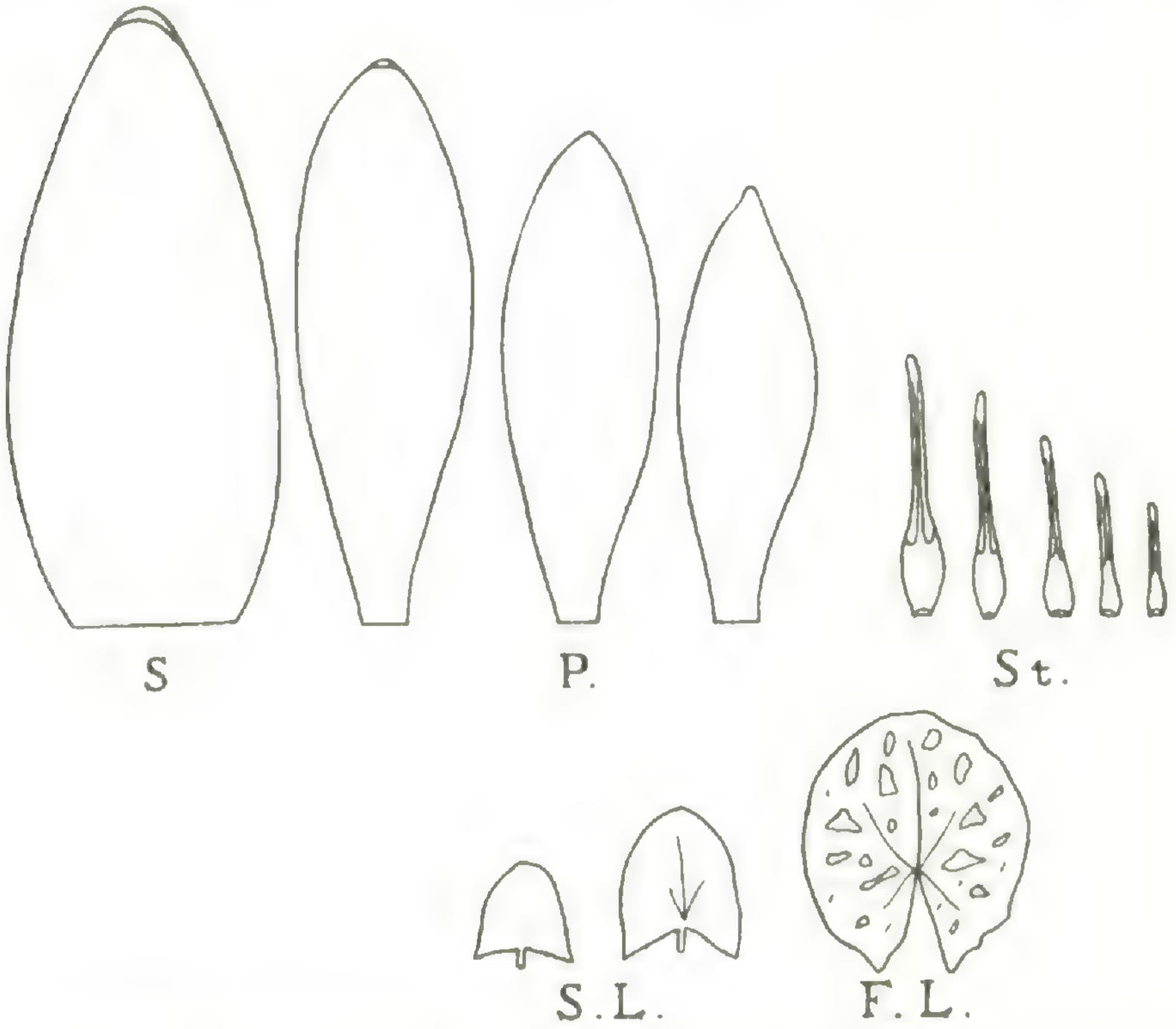
× NYMPHAEA CASTALIIFLORA (BRACHYCERAS), PRING

N. capensis zanzibariensis f. *rosea* ♀
×
N. capensis zanzibariensis f. *rosea* ♂
—*N. castaliiflora*, Pring (1913)

This pink-flowered hybrid is the result of intercrossing two light pink forms of *N. capensis* var. *zanzibariensis* during 1912, the progeny being a great improvement over any previous hybrid. It was self-pollinated, with the object of fixing the light pink color, and during the first year one hundred plants were cultivated. The results showed 2 per cent of blue flowers, which, however, were inferior to the pink both in the size and number of the floral segments. The remaining 98 per cent were of the dominant light pink color. The second year of self-pollination revealed flowers with a total exclusion of the blue color, the same dominant pink color being present, and the third year's experiments produced the same results. Homoeosis is well represented in the flower which bears four complete rows of petals, while other members of the Brachyceras group usually have but three. The arrest of the outer row of stamens is evidenced occasionally by a slight malformation of one or two petals, with indications of the bilocular anthers at the apex. The flower suggests the subgenus *Castalia* by its ovoid buds and the open petals which rest on the surface of the water during the third and fourth day.

Description—Flowers 8-10 inches across; bud ovoid, light green; peduncle brownish-green; sepals ovate, prominently hooded at the apex, 3⅞ inches long, 1½ inches wide, light green with pink margins without, within light pink, light

green at the base, showing 10-15 nerves; petals 45-60, light pink, outermost row slightly hooded at the apex, 3½ inches long, ⅞-1 inch wide, striped with green without, 7–8-nerved; stamens 300-325, outermost row 1¾ inches long, yellow, pink



Nymphaea castaliiflora: **S., sepals; P., petals; St., stamens; S. L., submerged leaves; F. L., floating leaves. About ⅓ natural size.**

at the apex, inner rows white at the apex; carpels 45-50, the styles yellow; fruit globose, containing numerous fertile seeds if pollinated through insect agency, not producing many when artificially pollinated; leaves of submerged seedling broadly triangular, with acute lobes, light green; primary floating leaves orbicular-sagittate with undulate margins, prominently blotched with reddish-brown above, dark pink to pinkish-red beneath; mature leaves orbicular, peltate, obtusely sinuate-dentate, 15 inches in diameter, lobes overlapping, green sparsely spotted with light brown above, reddish-

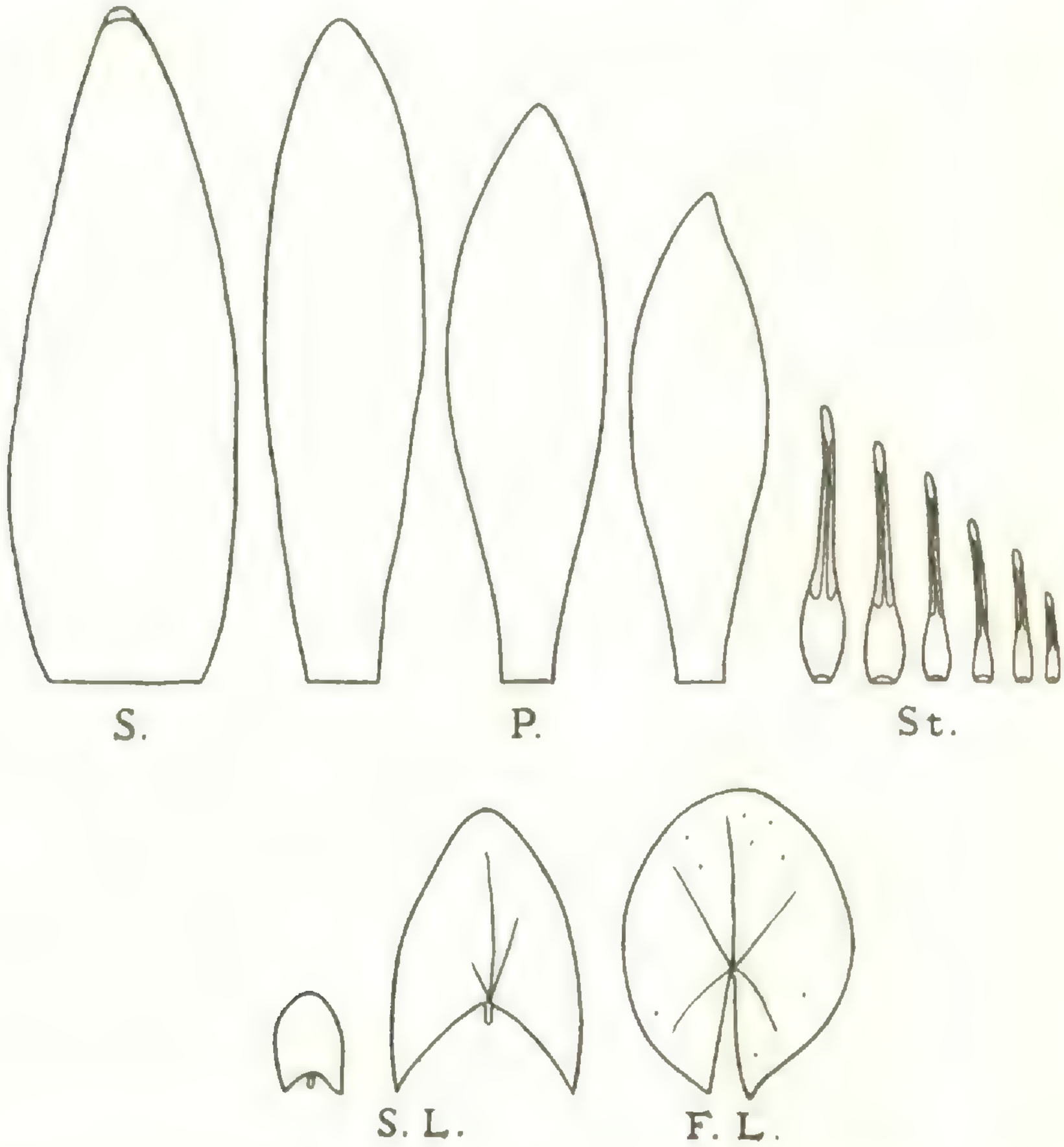
pink beneath; petioles brown, often attaining a length of 6 feet when fully developed.

× NYMPHAEA "MRS. EDWARDS WHITAKER" (BRACHYCERAS), PRING

N. capensis zanzibariensis f. *rosea* ♀
×
N. capensis zanzibariensis f. *rosea* ♂
→ *N. castaliiflora* ♂
×
N. ovalifolia ♀
→ **N. "Mrs. Edwards Whitaker," Pring (1917)**
and
N. "Mrs. Edwards Whitaker" var. *marmorata*, Pring (1917)

The dominant blue color of this hybrid is no doubt derived from *N. ovalifolia,* as the pink *N. castaliiflora* is apparently fixed, and suggests that *N. ovalifolia* has blue parentage. An improvement over either parent is evident in the size of the flower. The markings on the sepals are more prominent than in *N. ovalifolia,* whereas in *N. castaliiflora* they are entirely absent. The seed-pods contain a very low percentage of fertile seed compared with either parent. The leaves are fairly intermediate, suborbicular-sagittate, with slightly undulate margins, and the under side shows an increase of maculations over *N. ovalifolia,* from which parent they are transmitted. The red color on the under side of the seedling leaves suggests *N. castaliiflora,* this factor, however, being lost in the mature leaves. The leaves of the variety *marmorata* show a reddish-pink color, with the marmorations intensified above. This intensifying of some factors which are only transmitted from a single parent is interesting. Previously described hybrids which contain *N. caerulea,* the Egyptian blue lily, show the same peculiarity.

Description — Flowers 10-14 inches across, 4-8 open at one time; bud narrowly ovoid, dark green prominently striped with dark purple; peduncle green; sepals ovate,



Nymphaea "Mrs. Edwards Whitaker": S., sepals; P., petals; St., stamens; S. L., submerged leaves; F. L., floating leaves. About ½ natural size.

slightly hooded at the apex, 4¾ inches long, 1½ inches wide, outer surface dark green prominently striped with dark purple, campanula-blue toward the margins, within pale campanula-blue, light green at the base, showing 10-15 nerves; petals 30-35, campanula-blue, bleaching to white, outermost

row 4½ inches long, 1 inch wide, without suffused with green and striped with purple, 6–8-nerved; stamens 170-180, outermost row 2⅛ inches long, yellow, campanula-blue at the tips, inner rows white at the tips; carpels 30-35, the styles yellow; fruit globose, containing few fertile seeds; leaves of submerged seedling light green, oval to deltoid, with acute lobes; first floating leaves ovate-sagittate, light green occasionally spotted with dark green above, dark red densely spotted with purplish-blue beneath; mature leaves suborbicular-sagittate, peltate, with slightly undulate margins, 15 inches in diameter, lobes overlapping, above dark green rarely spotted with brownish-green at the base, beneath light green with purplish-blue spots which become smaller toward the margins; petioles dark green, often measuring 8-10 feet when fully developed.

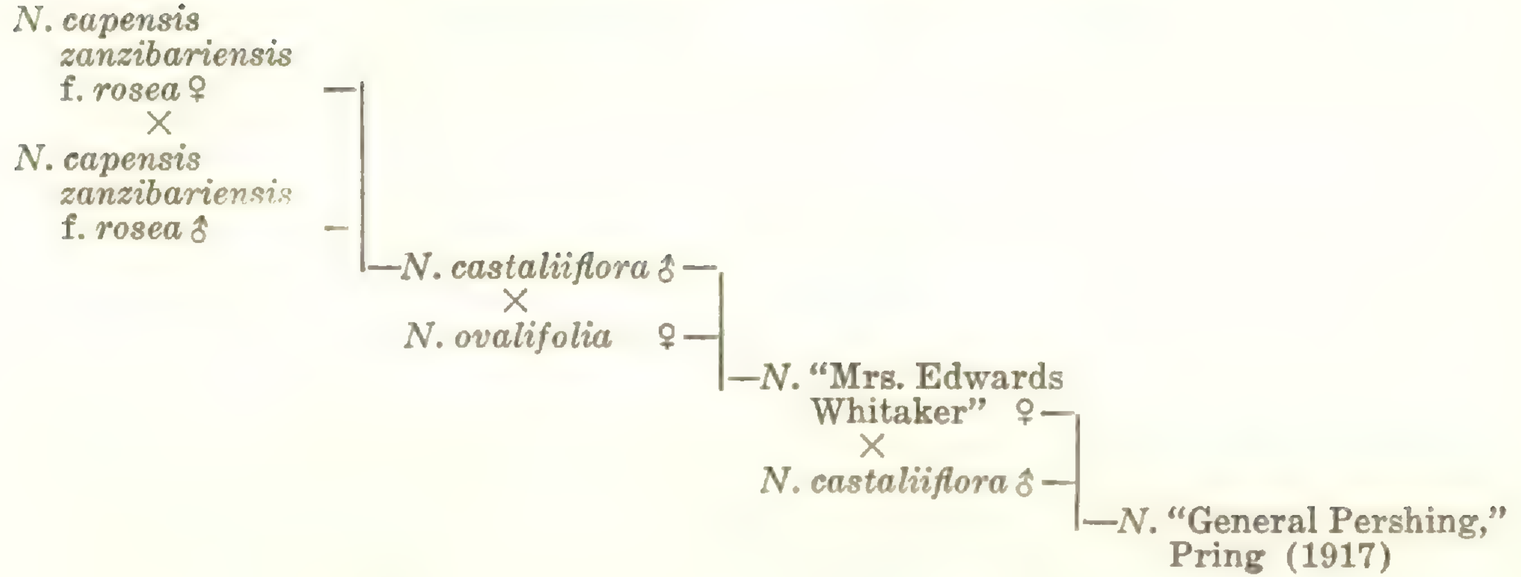
Var. *marmorata*—Flowers cup-shaped, smaller and darker blue than the type; submerged leaves same as in the type; first floating leaves light green irregularly blotched with reddish-brown above, dark red densely spotted with purplish-blue beneath; mature leaves almost entire at the apex, lobes overlapping, above prominently blotched with dark red, slightly fading with age, beneath light green suffused with pink and spotted with purplish blue.

× NYMPHAEA "GENERAL PERSHING" (BRACHYCERAS), PRING

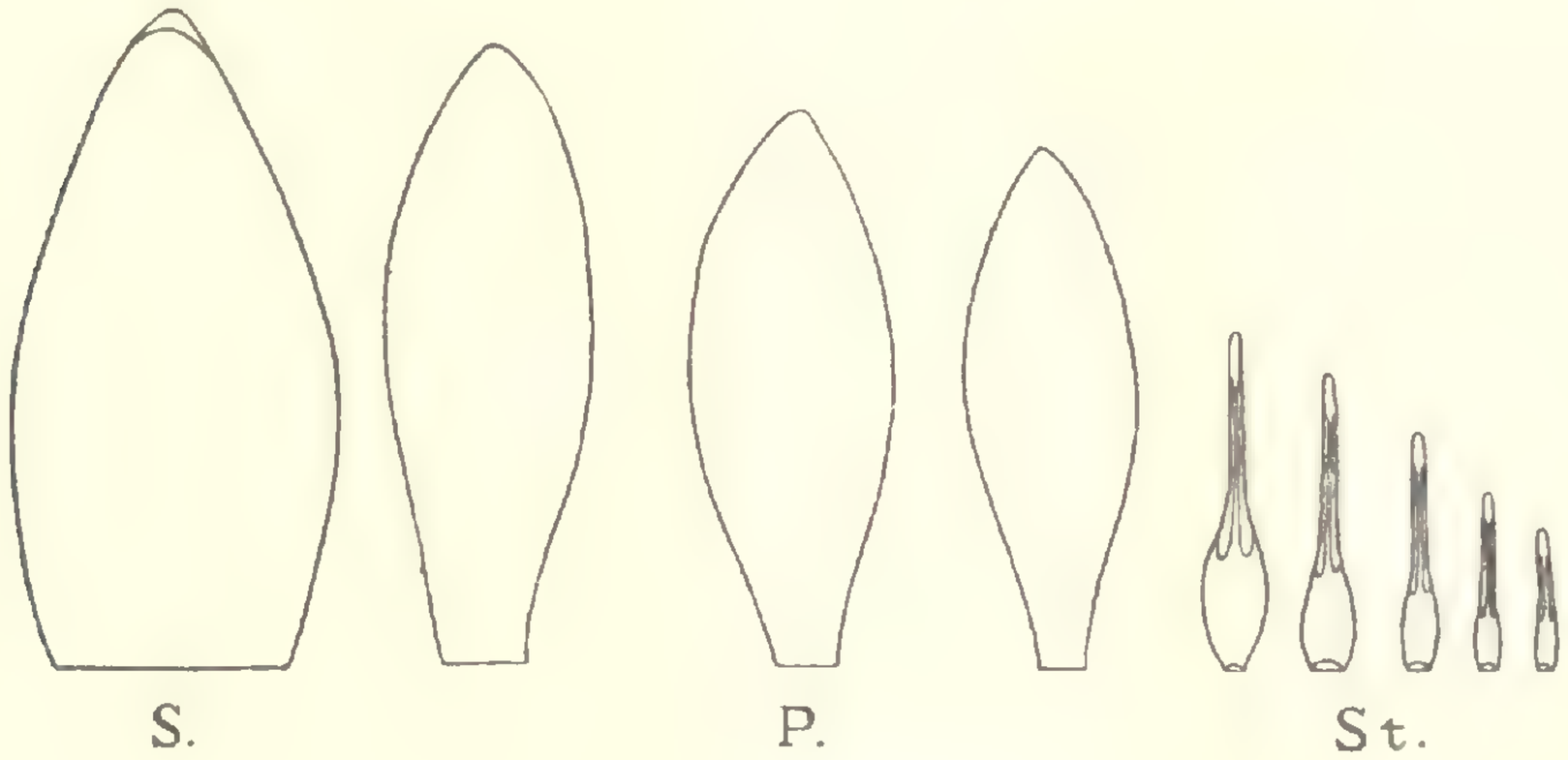
The flower of this hybrid resembles that of the staminate parent in the concave formation of the pistils and in the compactness of the formation of 3 distinct rows of light pink petals. The leaves are similar to those of the seed parent, being dark green conspicuously blotched with dark purple above, beneath green to greenish-red toward the margins and spotted with a slightly darker color, but the margins are more undulate than those of either parent. This is one of the most popular of the pink hybrids.

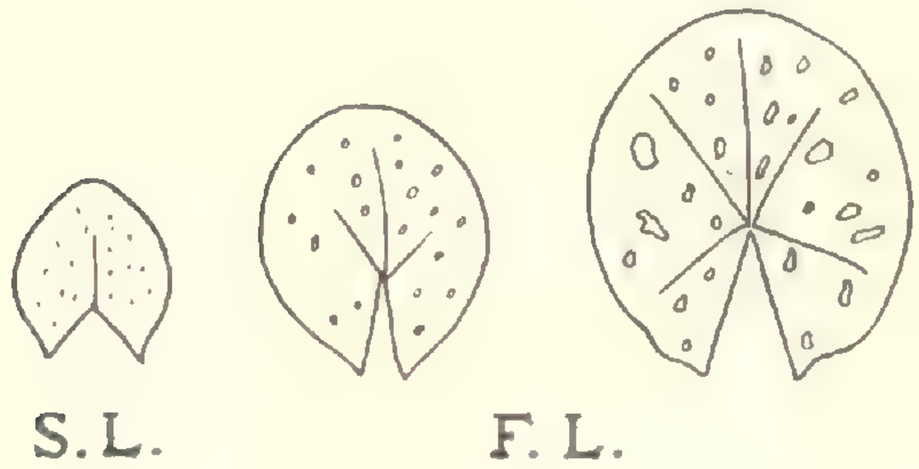
Description — Flowers 8-10 inches across; bud narrowly ovoid, dark green prominently striped with dark purple toward the apex; sepals ovate, hooded at the apex, 4 inches long, 1¾ inches wide, outer surface dark green striped with

NYMPHAEA "GENERAL PERSHING"



purple, lighter at the base, light pink toward the margins, within pinkish-white, light green at the base, showing 10-12 nerves; petals 30, light pink, outermost row slightly hooded at the apex, 3¾ inches long, ⅞ of an inch wide, suffused



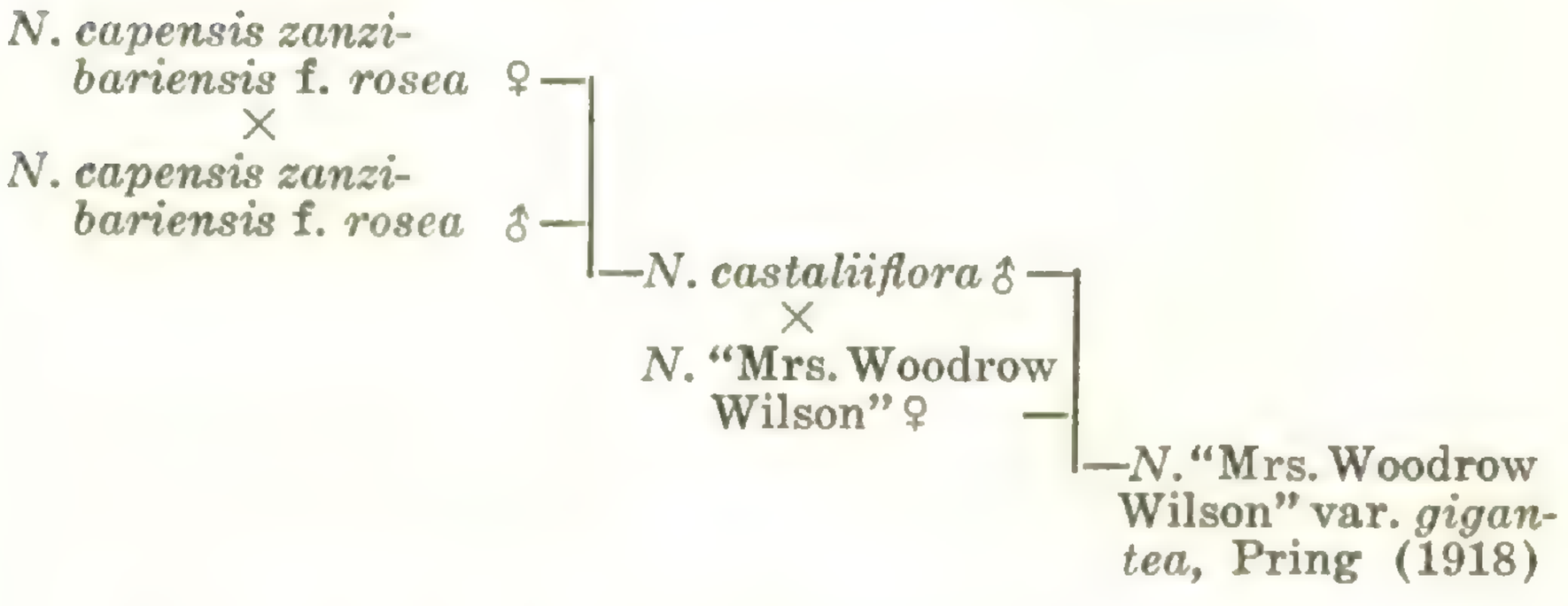


Nymphaea "General Pershing": S., sepals; P., petals; St., stamens; S. L., submerged leaves; F. L., floating leaves. About ⅜ natural size.

with green and striped with purple, light pink toward the margins, 7-nerved; stamens about 300, outermost row occasionally becoming petaloid, 1⅞ inches long, bright yellow at the base, pink and pinkish-white at the apex, inner rows yellow, yellowish-white at the apex; carpels 35-40, the styles dark yellow; fruit globose, containing fertile seeds; leaves of submerged seedling ovate to deltoid, light green with reddish-brown spots; first floating leaves orbicular-sagittate, above dark green spotted with greenish-brown, beneath light green

tinged with bluish-brown and spotted with purple; mature leaves suborbicular-sagittate, with undulate margins, 14 inches in diameter, lobes short, acute, overlapping, sinus nearly closed, above dark green spotted with brownish-purple, brownish toward the margin, beneath light green, pinkish spotted with reddish-brown toward the margins; petioles brown.

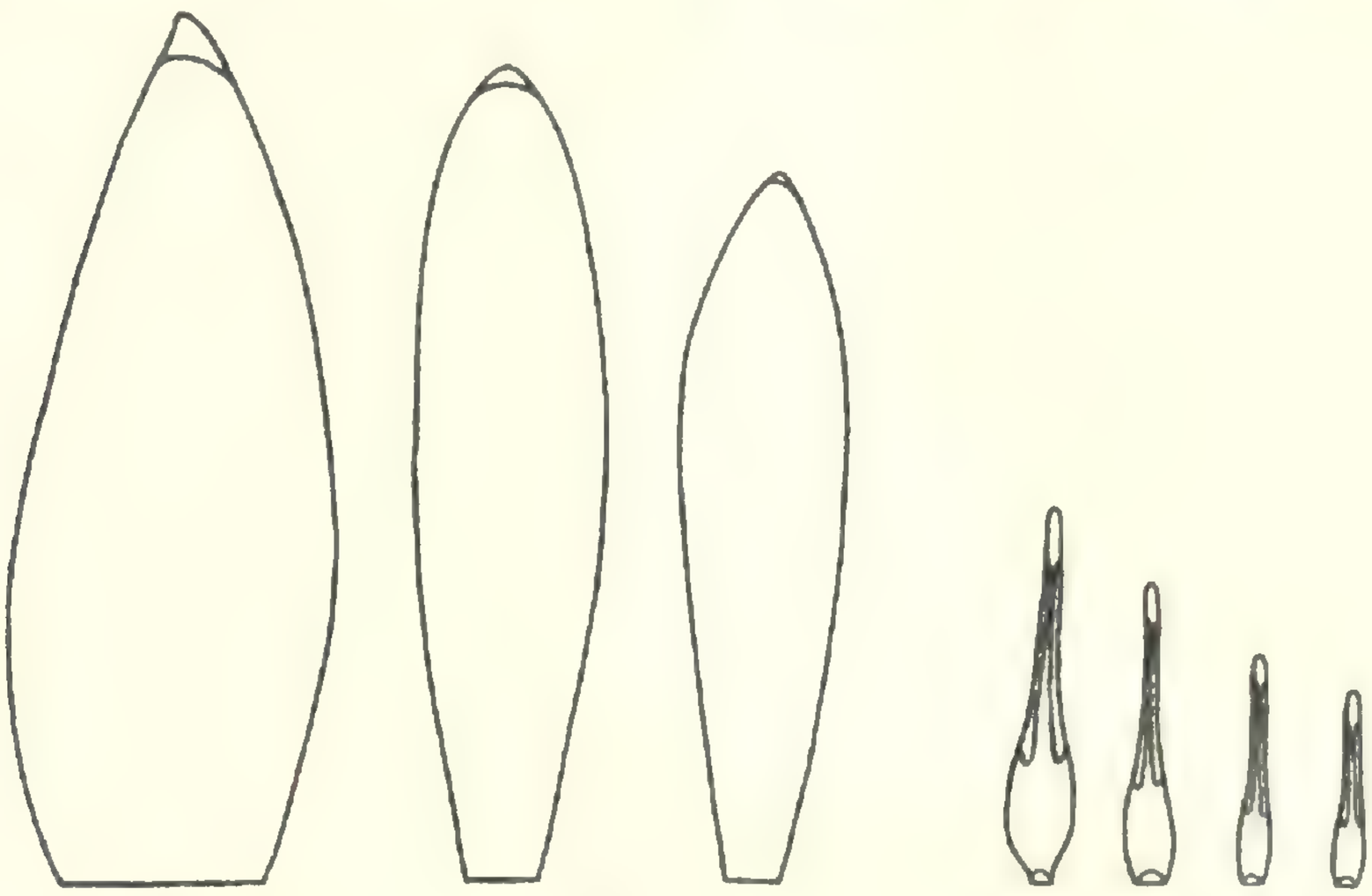
× NYMPHAEA "MRS. WOODROW WILSON" VAR. GIGANTEA (BRACHYCERAS), PRING

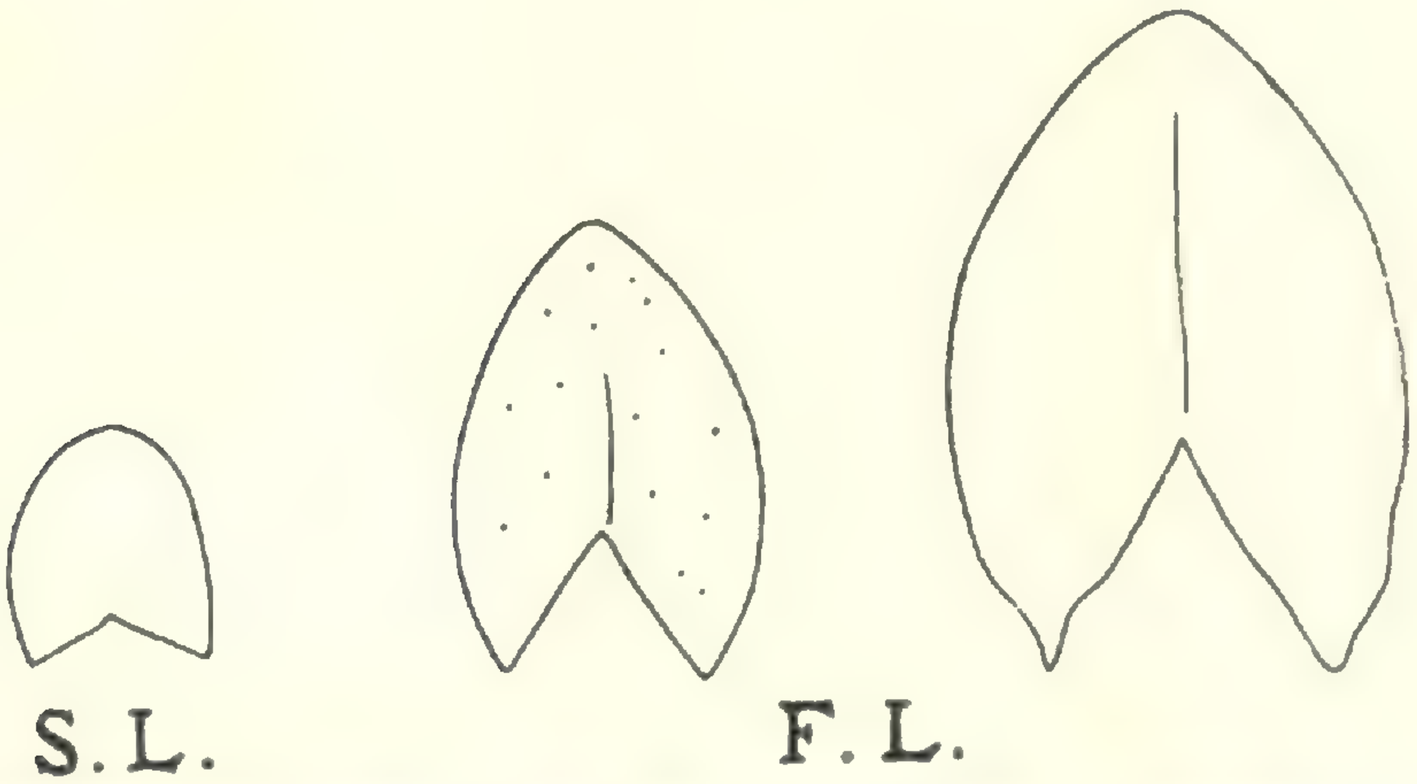


The viviparous habit of *N. micrantha,* the West African species, is a dominant factor transmitted through *N. Daubeniana* to the pistillate parent of this hybrid. The flowers have retained the bluish color of those of the seed parent, "Mrs. Woodrow Wilson," while the influence of the staminate parent, *N. castaliiflora,* is apparent in the larger sepals and petals and the pinkish color in the sepals and the outer row of petals. The purple markings on the leaves are more numerous than in *N.* "Mrs. Woodrow Wilson"; they are totally absent in the sepals and petals of *N. castaliiflora.*

The hybrid so strongly resembles "Mrs. Woodrow Wilson" that a varietal name has been given. It may be distinguished from it, however, by the tall peduncles terminating in a much larger flower, darker blue color, pink in the sepals and petals, the intensified markings externally, the larger leaf lobes overlapping one-third, and the deeply undulate margin.

Description — Flowers 7-8 inches across; bud narrowly ovoid, green; sepals ovate-oblong, prominently hooded at the apex, 3½ inches long, 1¼ inches wide, outer surface



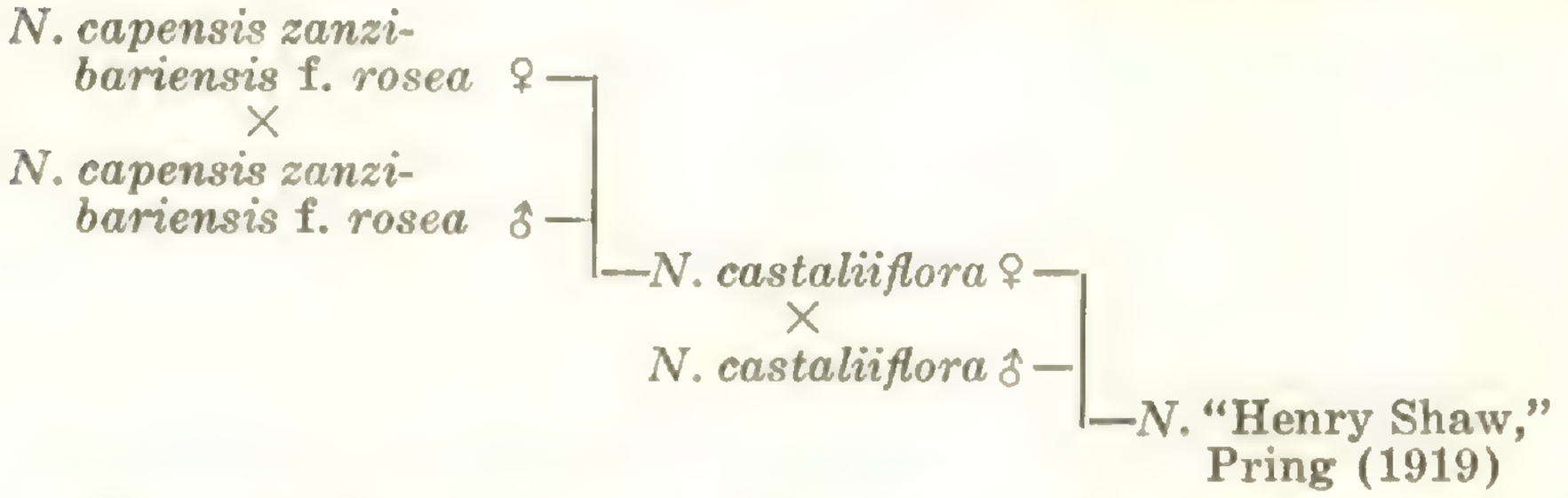


Nymphaea "Mrs. Woodrow Wilson" var. *gigantea*: S., sepals; P., petals; St., stamens; S. L., submerged leaves; F. L., floating leaves. About ⅜ natural size.

green striped with purple, suffused with blue toward the margins, yellowish-green at the base, within pinkish-white,

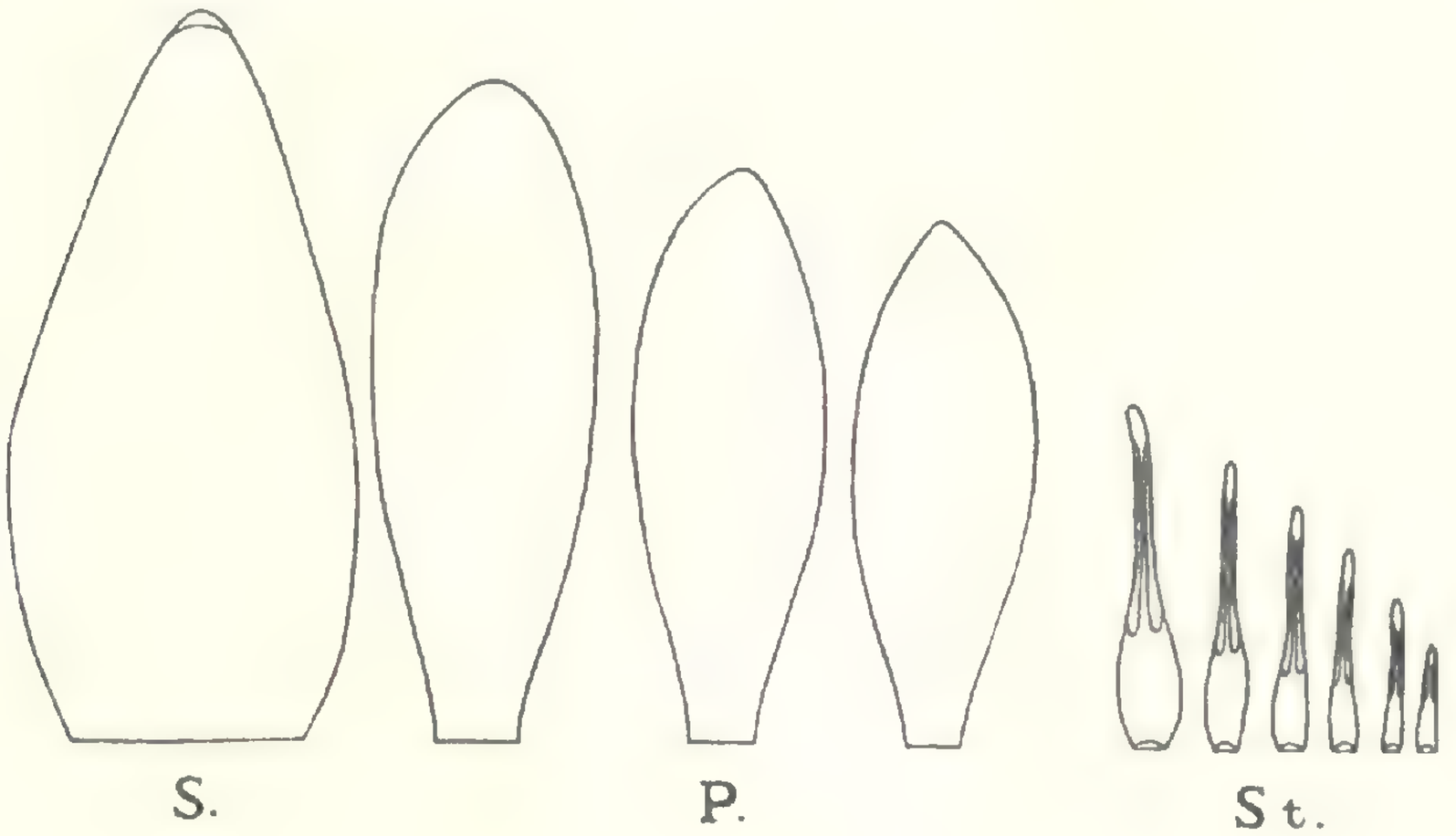
showing 10-12 nerves; petals 20-25, outermost row hooded at the apex, 3½ inches long, ⅞ of an inch wide, green prominently striped with purple without, blue toward the margins, 7–8-veined, pinkish-blue within, inner rows campanula-blue; stamens 140-150, outermost row 1½ inches long, brown without, pinkish-blue at the apex, inner rows yellow, white at the apex; carpels 25-30, the styles short; fruit globose, containing very few fertile seeds; leaves of submerged seedling ovate to deltoid, with acute lobes, light green; secondary leaves light green with prominent brownish marmorations; first floating leaves suborbicular-sagittate, with acute lobes, dark green sparsely spotted with brown above, brownish-pink beneath; mature leaves orbicular-sagittate, obtuse, irregularly sinuate-dentate, 14 inches in diameter, above green, viviparous at the insertion of the petiole, beneath pinkish-green; petioles green.

× NYMPHAEA "HENRY SHAW" (BRACHYCERAS), PRING



This hybrid, named in honor of the founder of the Missouri Botanical Garden, has been shown in the Garden collection annually since 1917. The plant appeared in the second generation of *N. castaliiflora,* the blue color occurring in only about two per cent of the crosses. It is of interest that later experiments of self-pollinating "Mrs. Edwards Whitaker" gave this same recessive blue-flowered plant (*N. castaliiflora* being the staminate parent of *N.* "Mrs. Edwards Whitaker"). In general characteristics the "Henry Shaw" resembles *N. castaliiflora;* in fact it is impossible to tell one from the other until the flowering period. The sepals are prominently hooded and solid green, all dark markings being

absent. The seedling leaves are prominently marmorate on the upper surface, while the mature leaves, like those of the parent, are suffused with pinkish-red beneath, the upper sur-



Nymphaea "Henry Shaw": S., sepals; P., petals; St., stamens; S. L., submerged leaves; F. L., floating leaves. About ½ natural size.

face being green sparsely spotted with light brown when young.

Description — Flowers 8-10 inches across; bud ovoid green; peduncle brown; sepals ovate, hooded at the apex, 4 inches long, 2 inches wide, outer surface green, campanula-blue towards the margins, within campanula-blue, showing

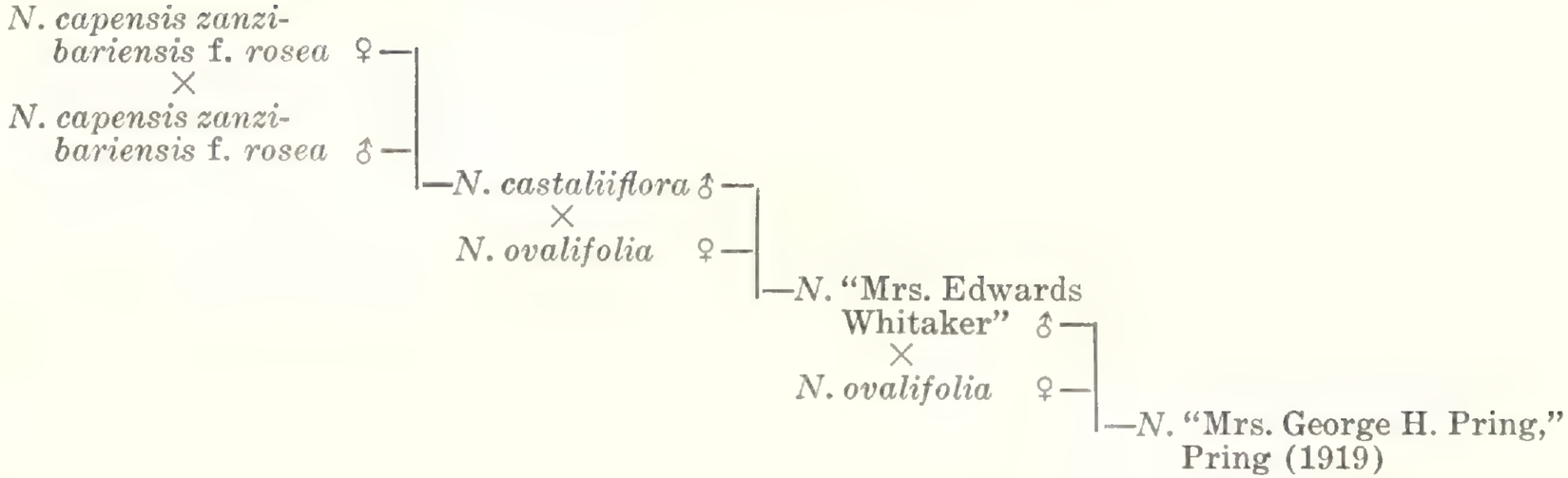
10-12 nerves; petals 28-30, campanula-blue, outermost row slightly hooded at the apex, 3¾ inches long, 1 inch wide, somewhat suffused with green without, 7-veined; stamens about 260-280, outermost row 2 inches long, occasionally becoming petaloid, lemon-chrome tipped with campanula-blue, inner rows tipped with yellowish-white; carpels 35-40, the styles lemon-chrome; fruit globose, containing numerous seeds; leaves of submerged seedlings ovate to deltoid, light green; primary floating leaves orbicular-sagittate, above dark green, beneath light green suffused with pink; mature leaves oval-sagittate, peltate, margin irregularly sinuate, 15 inches in diameter, sinus open one-third, above dark green with brown spots, beneath pinkish-red; petioles brown, often 6 feet in length.

× NYMPHAEA "MRS. GEORGE H. PRING" (BRACHYCERAS), PRING

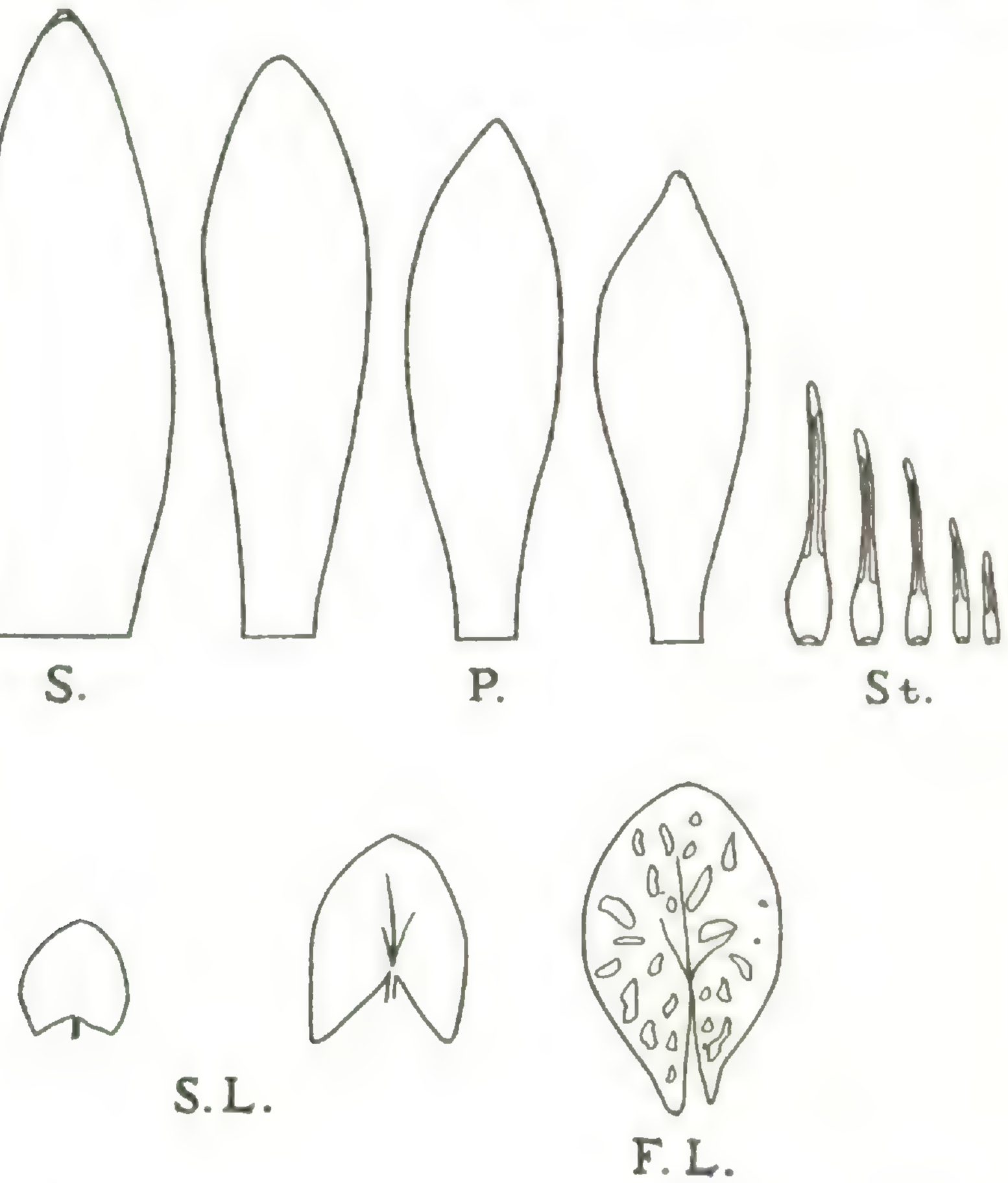
When the flowers of this hybrid had finally reached a stage of development superior to the white-flowered *N. gracilis,* specimen flowers were submitted to the Society of American Florists and Ornamental Horticulturists in convention at Kansas City, August 15, 1922, and the lily was awarded honorable mention. Mr. Charles Tricker, water-lily specialist, of Arlington, N. J., visited the Garden after the convention, in the capacity of official judge, to report on the condition of the plant as growing in the pool. He stated that "the new hybrid presents the biggest one jump in the development of a new water-lily to date."

Description — Flowers 8-10 inches across; bud narrowly ovoid-conical, light green with minute dark purple lines; peduncle green; sepals ovate-oblong, somewhat hooded at the apex, 4¼ inches long, green irregularly striped with dark purple without, within white, greenish-white at the base, showing 10-12 nerves; petals white, outermost row 4 inches long, ¾-1 inch wide, light green at the thickened base, 6–8-veined; stamens 120-130, canary-yellow, outer rows 2 inches long, white at the apex; carpels 28-30, the styles yellow; fruit globose, well filled with fertile seeds; mature leaves oval-sagittate, peltate, with sinuate-undulate margins, more deeply

NYMPHAEA "MRS. GEORGE H. PRING"



sinuate at the base, almost entire at the apex, 16 inches long, 14 inches wide, lobes overlapping, above green faintly spotted

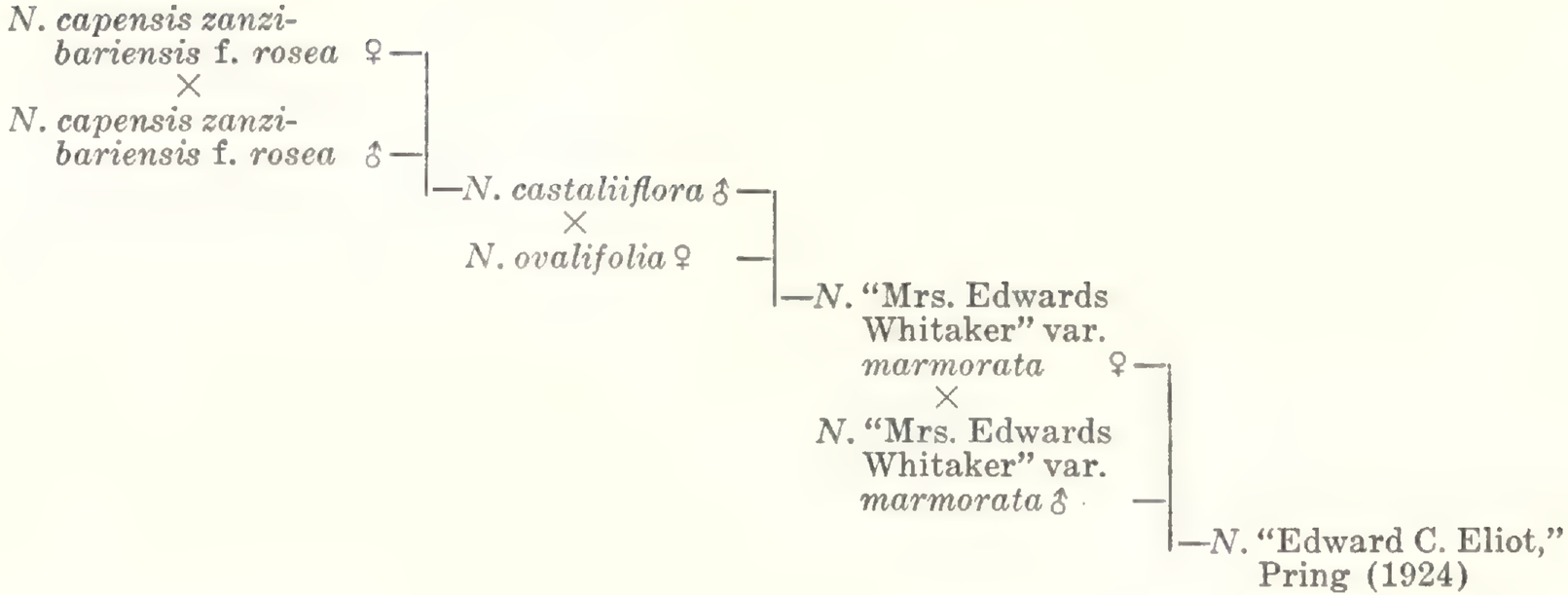


Nymphaea "Mrs. George H. Pring": S., sepals; P., petals; St., stamens; S. L., submerged leaves; F. L., floating leaves. About ½ natural size.

with reddish-brown, fading with age, beneath light green suffused with pink; petioles light brown, measuring 6-8 feet when fully developed.

Var. *marmorata*—Flowers same as type; leaves light green, irregularly blotched with reddish-brown above. This mar-

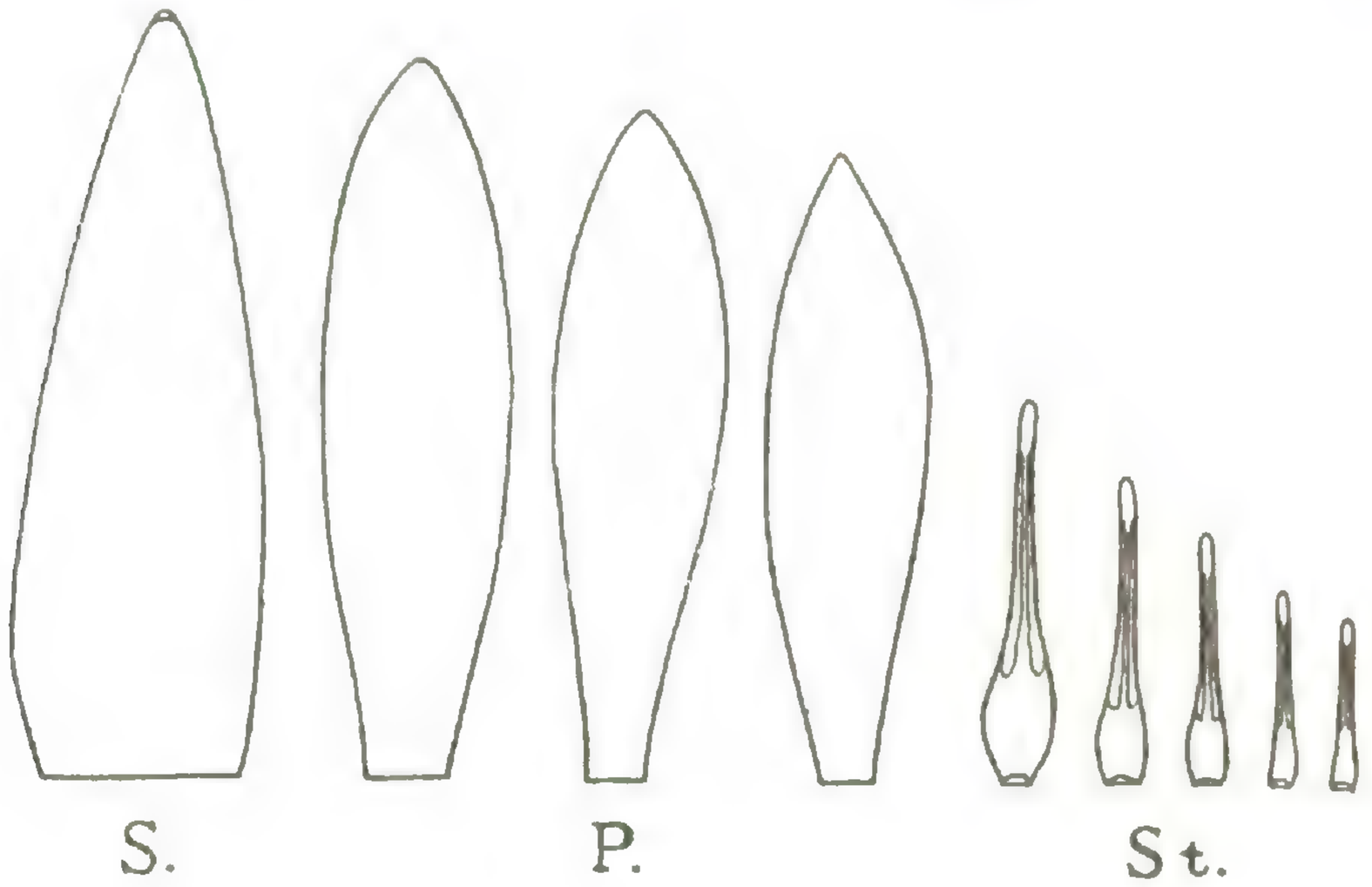
NYMPHAEA "EDWARD C. ELIOT"

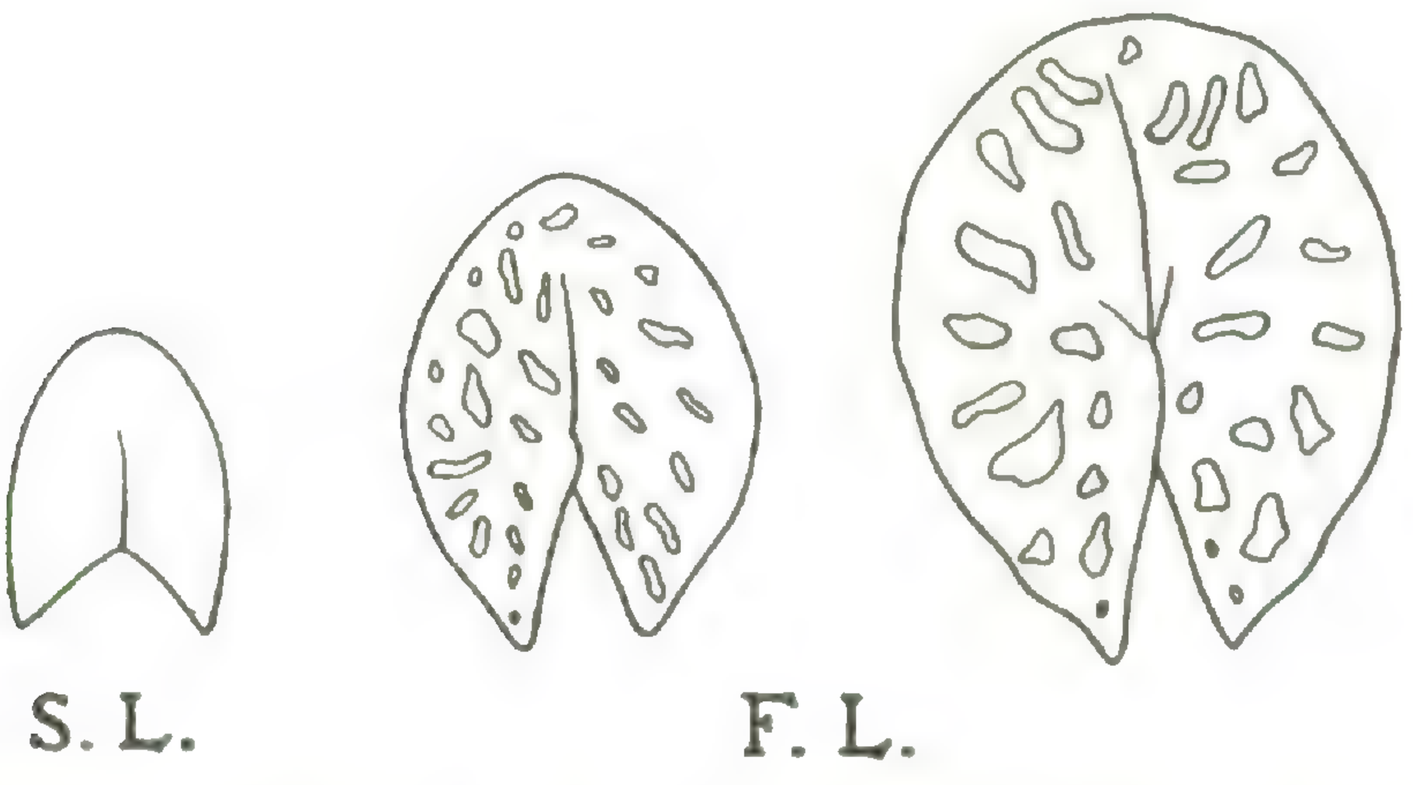


moration is transmitted through *Nymphaea* "Mrs. Edwards Whitaker."

× NYMPHAEA "EDWARD C. ELIOT" (BRACHYCERAS), PRING

During 1923 an attempt was made to produce a new pink-flowered water-lily. "Mrs. Edwards Whitaker" var. *marmor-*





Nymphaea "Edward C. Eliot": S., sepals; P., petals; St., stamens; S. L., submerged leaves; F. L., floating leaves. About ½ natural size.

ata was self-pollinated, and several hundred seedlings were raised during the following season. From these there was selected a form having the intensified leaf coloration of the parents but with the pink flowers of *N. castaliiflora.* This well-marked variety was named in honor of Edward C. Eliot, then president of the Board of Trustees of the Missouri Botanical Garden.

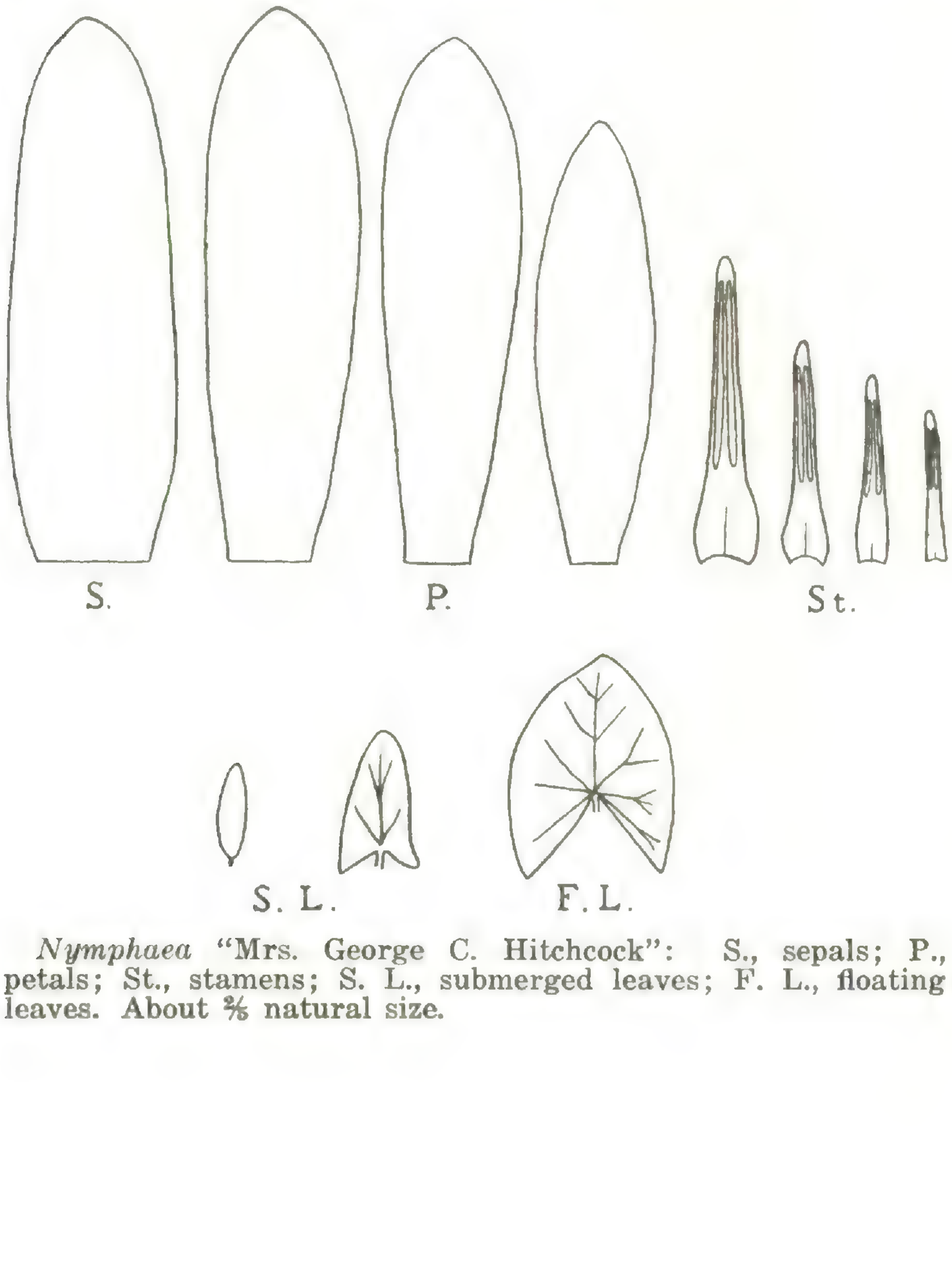
Description — Flowers 8-10 inches across; bud narrowly ovoid, light green spotted with pinkish-red; peduncle brown; sepals ovate-oblong, hooded at the apex, 4½ inches long, 1½ inches wide, outer surface parrot-green irregularly striped with reddish-pink, pale amaranth-pink toward the margins, within pale amaranth-pink, light green at the base, showing 13 nerves; petals 36, amaranth-pink, outermost row slightly hooded at the apex, 4 inches long, 1 inch wide, 7–8-veined; stamens 200, outermost row 2 inches long, lemon-yellow, pale amaranth-pink at the apex, the inner rows almost entirely lemon-yellow; carpels 36-40, the styles lemon-yellow; fruit globose, containing numerous fertile seeds; leaves of submerged seedling broadly triangular with acute lobes, light green; first floating leaves orbicular-sagittate, above prominently marmorated with reddish-brown, beneath pink; mature leaves broadly oval-sagittate, peltate, margins irregularly sinuate-dentate, 16-18 inches in diameter, lobes overlapping, above dark green prominently marmorated with reddish-brown, beneath spotted with reddish-pink; petioles green, often attaining a length of 6 feet when fully developed.

× NYMPHAEA "MRS. GEORGE C. HITCHCOCK" (LOTOS), PRING

N. Lotus dentata ♀ × *N. Sturtevantii* ♂ — *N. Omarana* ♀ × *N. Omarana* ♂ — **N. "Mrs. George C. Hitchcock," Pring (1926)**

The flower of this hybrid is an improvement over its parents, *N. Omarana,* in number of petals and darker color. In shape it resembles its grandparent, *N. Sturtevantii.* During propagation from tubers it has been found to be very apt to revert to *N. Omarana* in color, but still maintaining its increased number of petals.

Description — Flowers 10-14 inches across, opening 4-5 successive nights from 7 P. M. to 10 A. M. during August; bud ovoid-oblongoid, purplish-brown; peduncle puberulent, purplish-brown; sepals ovate-oblong, rounded at the apex, 5 inches long, 1¼ inches wide, purplish-brown without,



Nymphaea "Mrs. George C. Hitchcock": S., sepals; P., petals; St., stamens; S. L., submerged leaves; F. L., floating leaves. About ⅔ natural size.

NYMPHAEA CASTALIIFLORA

NYMPHAEA "MRS. EDWARDS WHITAKER"

NYMPHAEA "GENERAL PERSHING"

NYMPHAEA "MRS. WOODROW WILSON" VAR. GIGANTEA

NYMPHAEA "HENRY SHAW"

NYMPHAEA "MRS. GEORGE H. PRING"

NYMPHAEA "EDWARD C. ELIOT"

NYMPHAEA "MRS. GEORGE C. HITCHCOCK"

NYMPHAEA BURTTII

NYMPHAEA "MISSOURI"

NYMPHAEA "ST. LOUIS"

NYMPHAEA "ST. LOUIS" VAR. MARMORATA

M. B. G. 96

M. B. G. 104 VIOLET

M. B. G. 104 PINK

M. B. G. 147

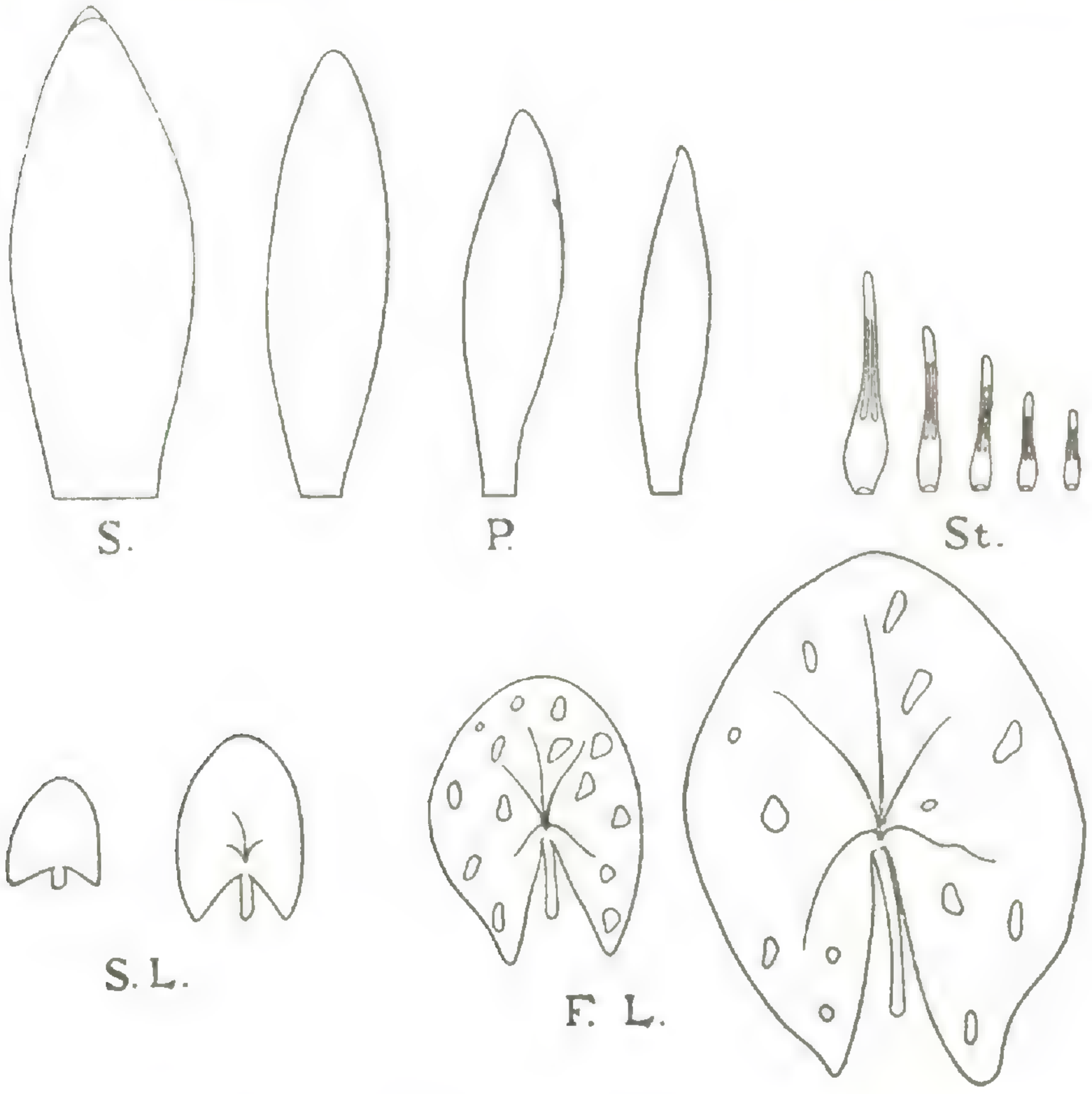
M. B. G. 162

showing 7 prominently raised veins of a lighter color, within dark rose-pink, lighter toward the base; petals 20-21, rose-pink, outermost row suffused with greenish-brown along the median vein, inner rows fading to white at the base; stamens 90, ligulate, erect the first night, exposing the ovary, later becoming inflexed at the apex, spreading at the base, half as long as the petals, orange-yellow tinged with rose, attached to the receptacle by a wide lunate base, inner rows purplish-brown bordering the anthers, orange without, becoming shorter and darker toward the center; ovary puberulent; carpels 24, styles orange-brown, erect the first night, later becoming inflexed; fruit 3 inches in diameter, containing numerous seeds; leaves of submerged seedlings hastate; floating leaves orbicular-sagittate, purplish-brown flecked with green; mature leaves suborbicular-sagittate, margins undulate, subspinose-dentate, 16 inches in diameter, lobes overlapping when young, sinus open with age, above purplish-brown, dark green at the center, becoming light brown with age, beneath purplish-brown, prominent brownish-green venation, pubescent; petioles 6-8 feet in length, purplish-brown, puberulent, in cross-section showing 2 large and 2 small air-canals surrounded by smaller ones.

NYMPHAEA BURTTII, PRING & WOODSON (1933)

Description — Flowers 6-8 inches across, 2-3 opening at one time; bud narrowly ovoid, light green; peduncle brown (occasionally green); sepals ovate-lanceolate, hooded at the apex, 3½ inches long, 1½ inches wide, light green towards the margins without, within primrose-yellow, light yellowish-green at the base, showing 10 nerves; petals 20-23, primrose-yellow, outermost row slightly hooded at the apex, 3½ inches long, ½ inch wide, within striped with green, green at the base, 5–6-veined; stamens 190-200, outermost row 1¾ inches long, cadmium-yellow tipped with primrose-yellow; carpels 28-30, the styles cadmium-yellow; fruit globose, 1 inch in diameter, containing numerous fertile seeds; leaves of submerged seedlings triangular-ovate, light green; second leaf ovate-sagittate with acute lobes; first floating leaves orbicular-

sagittate, lobes more or less acute, sinus open to the center, above green spotted with reddish-brown which fades out later, beneath light green; mature leaves orbicular-sagittate, peltate, margins irregularly undulate-sinuate, almost entire towards the apex, 15 inches long, 14 inches wide, lobes over-

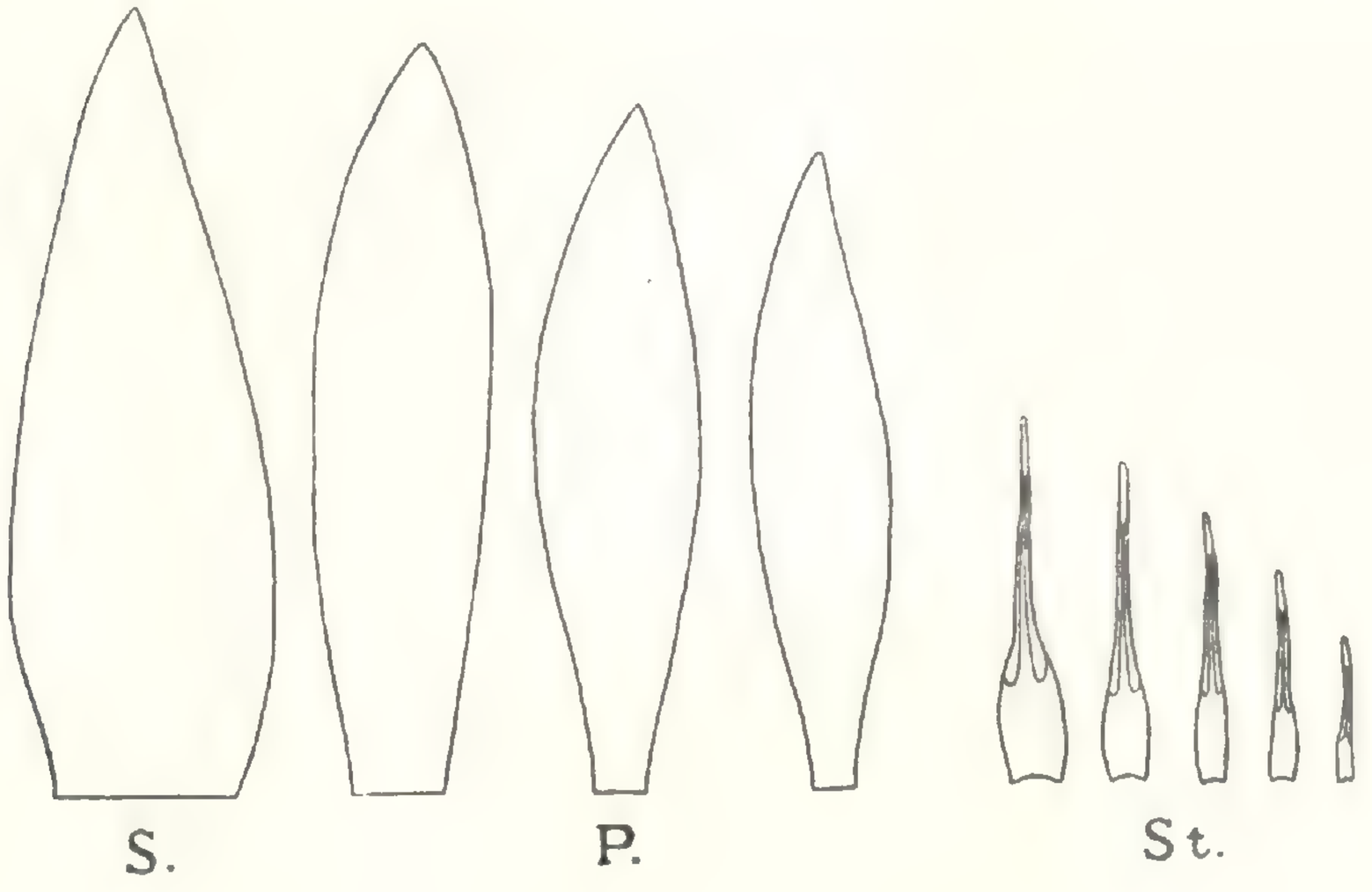


Nymphaea Burttii: S., sepals; P., petals; St., stamens; S. L., submerged leaves; F. L., floating leaves. About ⅓ natural size.

lapping one-third from the center, forming a raised keel, the remaining two-thirds gradually diverging, above pea-green flecked with reddish-brown which fades out later, beneath light green; petioles terete, brown (occasionally green in specimens with green peduncles), attaining a length of 6 feet when fully developed.

× NYMPHAEA M. B. G. 2 (BRACHYCERAS), PRING

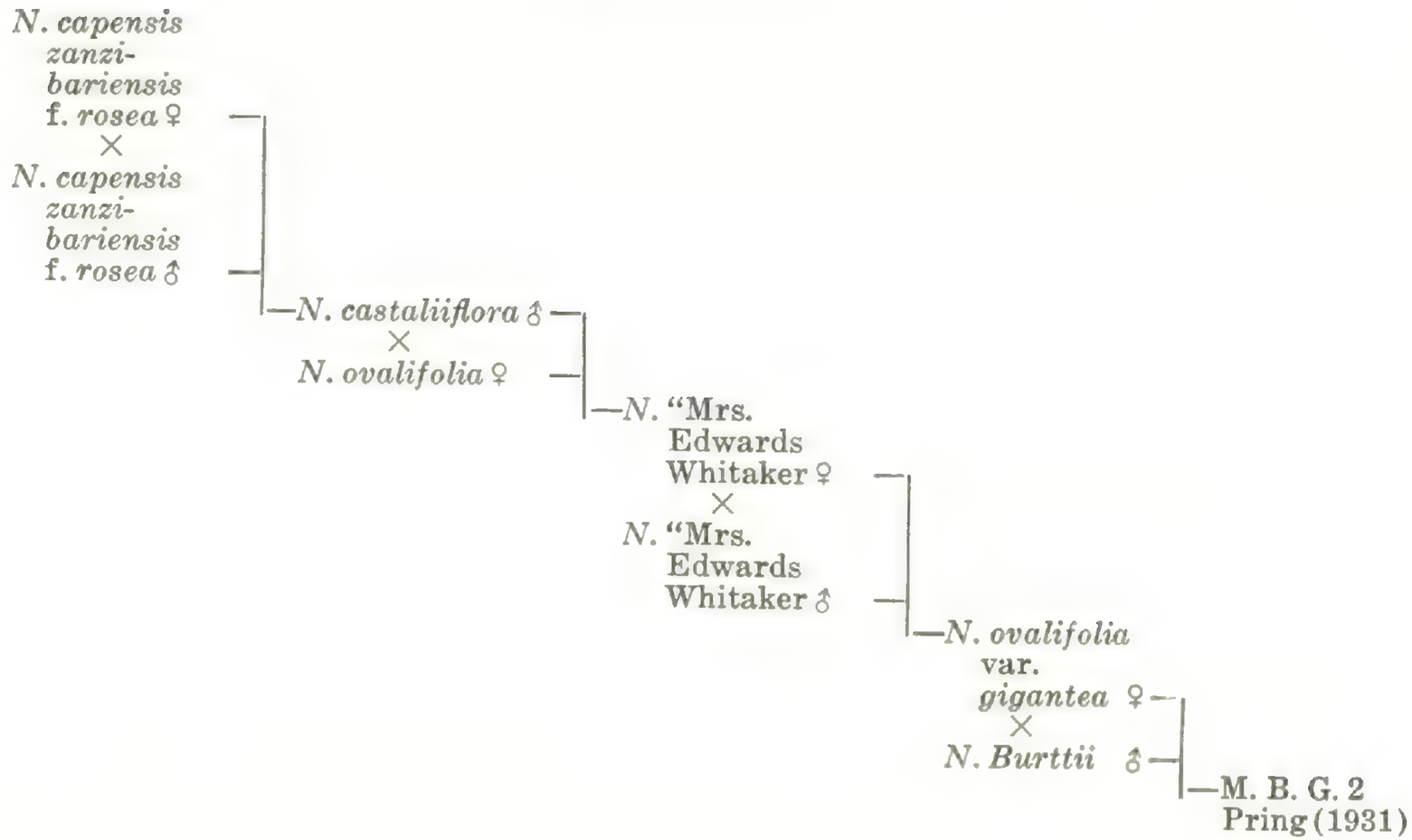
This yellow hybrid may easily be distinguished from the yellow *Nymphaea* "St. Louis" by the flowers and leaves. The stellate shape of the flowers resembles that of the seed parent,



M. B. G. 2: S., sepals; P., petals; St., stamens; S. L., submerged leaves; F. L., floating leaves. About 2/5 natural size.

N. ovalifolia, native of Africa, while *N.* "St. Louis" has cup-shaped flowers. A single fully developed plant of this hybrid often bears 6-8 flowers. The leaves are obtuse at the apex and of a relatively heavy texture, whereas in "St. Louis" var. *marmorata* they are rounded at the apex and delicate

NYMPHAEA M. B. G. 2



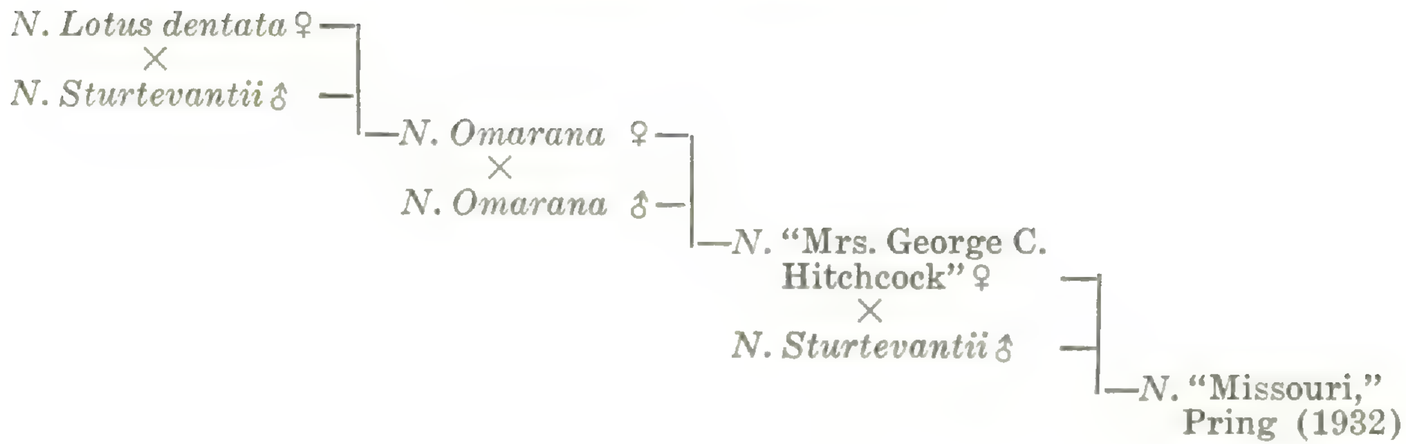
in texture. The sepals and petals with age show the same pink coloration noted in the latter. The prominent reddish-brown irregular markings upon the upper surface of the leaves and purple spots on the under surface are also very similar to the marmorate "St. Louis," these characters being transmitted from *N. ovalifolia*. This hybrid might be considered a yellow *ovalifolia*.

Description — Flowers 10-12 inches across, 3-6 opening at one time; bud very narrowly attenuate-ovoid, green prominently striped with dark purple; peduncle green; sepals ovate-lanceolate, 5 inches long, 1½ inches wide, within pale viridine-yellow, greenish-yellow at the base, showing 10-12 veins; petals 20-24, viridine-yellow, lanceolate-acuminate, outermost row 4½ inches long, 1 inch wide, striped with green and purple without, 6–7-veined; stamens 120-130, outermost row 2¼ inches long, light cadmium-yellow tipped with pale viridine-yellow; carpels 20-25, the styles light cadmium-yellow; fruit sub-globose, 2-3 inches in diameter, containing fertile seeds; leaves of submerged seedlings triangular-ovate with acute lobes; primary floating leaves oval-sagittate, above prominently and irregularly blotched with reddish-brown, beneath light green densely spotted with purple; mature leaves broadly oval-sagittate with irregularly undulate margins, 19 inches long, 14 inches wide, sinus open to the center when fully developed, above pea-green prominently marmorated with reddish-brown which fades with age, beneath light green spotted with purple fading with age; petioles green, attaining a length of 6 feet.

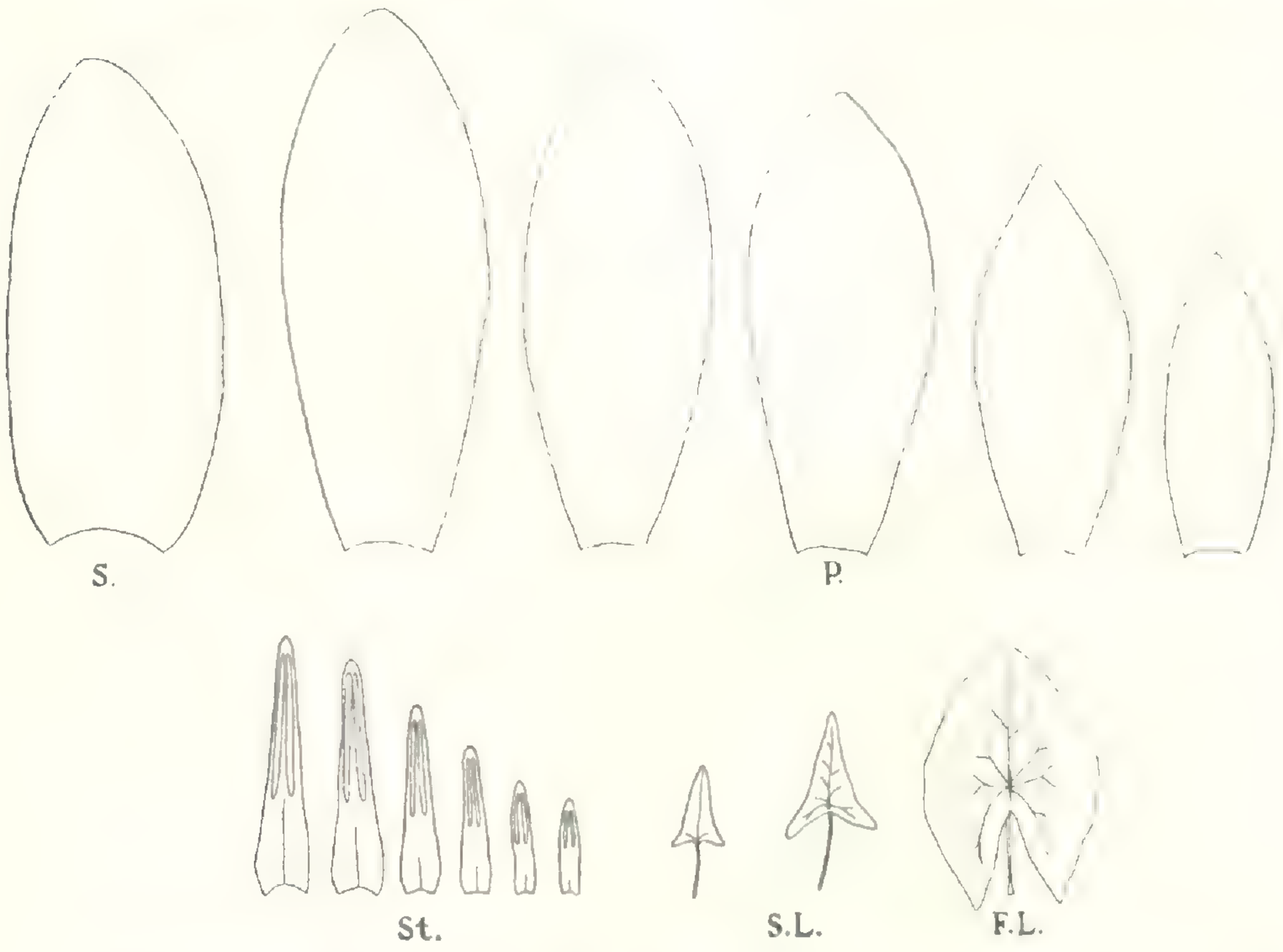
× NYMPHAEA "MISSOURI" (LOTOS), PRING

This hybrid might be considered a white *Sturtevantii* because of its very large semi-double flowers and the peculiar fluted-margined leaves. It is a member of the Lotos group but possesses several characters which distinguish it from the other members. It may be grown in a cooler temperature than other Lotos lilies; its flowers remain open longer during the day; and when propagated in the winter from tubers it will flower the following spring. Even in the seedling stage it can be recognized by its copperish-green leaves.

NYMPHAEA "MISSOURI"



Description — Flowers 10-14 inches across, opening 4-5 successive nights during August from 7 P. M. to 11 A. M.; bud ovoid-oblongoid, green suffused with copperish-green; peduncle puberulent, light green; sepals ovate-oblong, rounded at the apex, 5 inches long, 2 inches wide, green flushed with copperish-green without, showing 10 prominently raised veins of lighter color, within white; petals 30-



Nymphaea "Missouri": S., sepals; P., petals; St., stamens; S. L., submerged leaves; F. L., floating leaves. About ⅓ natural size.

35, white, 5¼ inches long, 2 inches wide, ovate-oblong, obtuse at the apex, outer row flushed with green without; stamens 100-110, ligulate, erect the first night, exposing the ovary, later becoming inflexed at the apex, spreading at the base, half as long as the petals, lemon-chrome, lighter toward the base, attached to the receptacle by a wide lunate base, inner rows lemon-chrome at the apex, red at the base; ovary puberulent; carpels 23-26, the styles erect the first night,

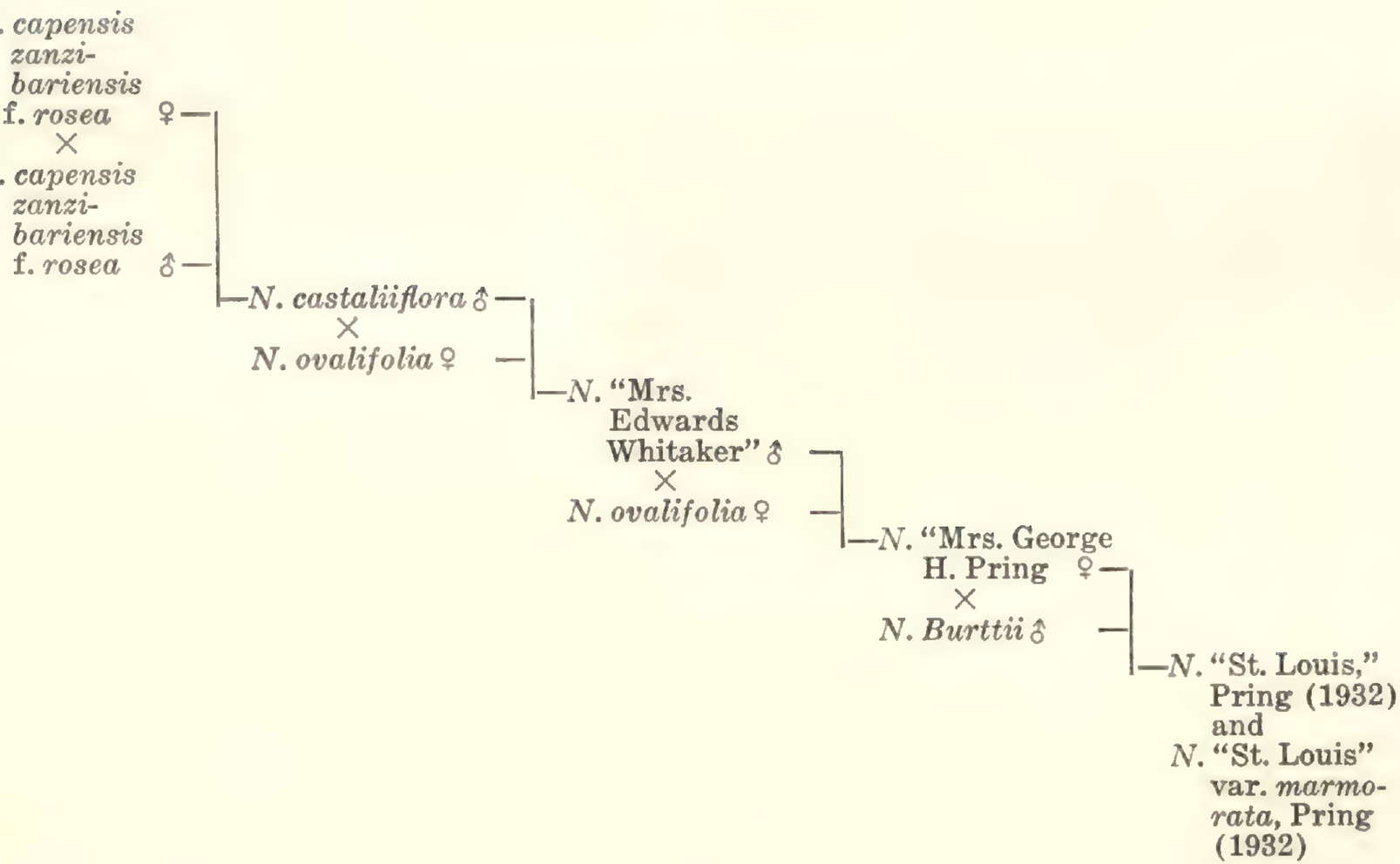
later becoming inflexed, red tinged with yellow at the apex; fruit 3 inches in diameter, containing numerous seeds; leaves of submerged seedlings hastate; first floating leaves broadly oval-sagittate, green flushed with copperish-brown; mature leaves orbicular-sagittate, peltate, margins subspinose-dentate, prominently fluted, 16 inches in diameter, above dark green suffused with copperish-brown which fades out with age, beneath dark green spotted and suffused with copperish-brown, the prominent venation lighter green and pubescent; petioles 6-8 feet in length, purplish-brown, puberulent, in cross-section showing two large air-canals surrounded by smaller ones.

× NYMPHAEA "SAINT LOUIS" (BRACHYCERAS), PRING

The "Saint Louis" lily is the most noteworthy of all the crosses of yellow parentage and the only one in which yellow is positively dominant, white, pink, and blue being absent. Unlike its staminate parent, *N. Burttii,* whose dormant tubers could not be forced into growth, this hybrid has proven an excellent propagator. During the winter 1932-33 many plants of the "Saint Louis" were successfully grown and flowered, and were exhibited at the National Flower and Garden Show in April, 1933. Its habit of growth and size of flowers are typical of its pistillate parent, while its color is the only character of the pollen parent, *N. Burttii.* The foliage shows the same variation as *N.* "Mrs. George H. Pring" and *N.* "Mrs. Edwards Whitaker," being either prominently marmorate or entirely green. When the marmorate character is transmitted, purple markings are shown on the under side. This interesting leaf coloration is inherited through the African parent, *N. ovalifolia,* which has played an important part in the Missouri Botanical Garden hybrids.

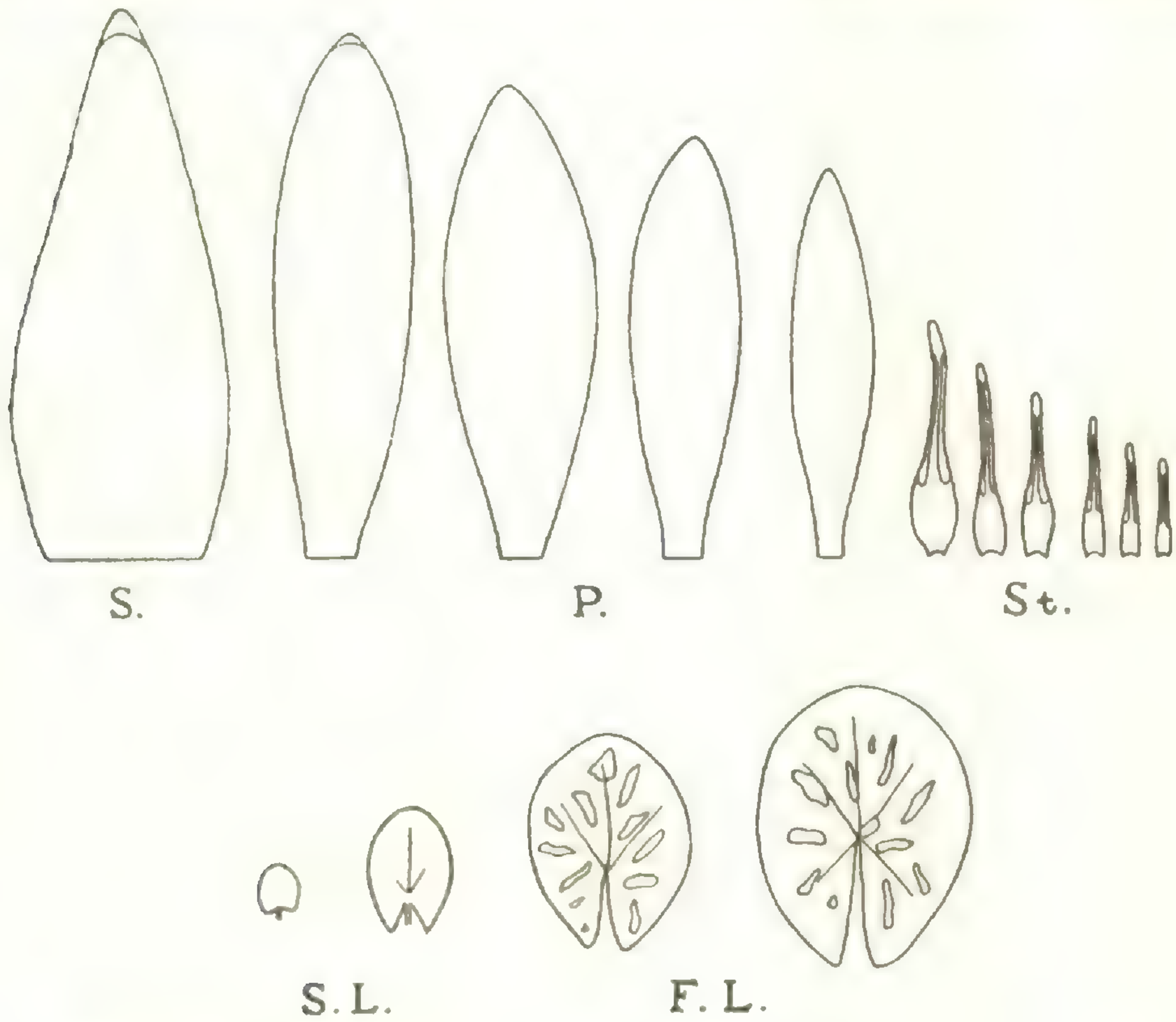
In comparing the green and marmorate varieties, the green-leaf hybrid possesses a greater number of petals, the buds are green upon brown peduncles, and the petioles are also brown. The variety *marmorata* has buds striped with purple supported upon green peduncles, and the petioles show the same green color; the old flowers fade to light pink toward the tips of the sepals and petals; and the leaves are

NYMPHAEA "ST. LOUIS"



more tender and are apt to be torn when handled or during a wind storm.

Description — Flowers 10-12 inches across; bud narrowly ovoid, light green; peduncle brown; sepals ovate-oblong, prominently hooded at the apex, 4½ inches long, 1¾ inches wide, outer surface green, paler toward the margin, within pale viridine-yellow, greenish-yellow at the base, showing 10-12 nerves; petals 30-38, viridine-yellow, comprising 4 rows, outermost row lanceolate, obtuse, slightly hooded at the apex, 4½ inches long, 1½ inches wide, somewhat suf-



Nymphaea "St. Louis": S., sepals; P., petals; St., stamens; S. L., submerged leaves; F. L., floating leaves. About ⅜ natural size.

fused with green as in the sepals, 6–8-veined; stamens 190-200, outermost row 2 inches long, pale lemon-yellow, pale viridine-yellow at the base; carpels 25-30, the styles pale

viridine-yellow; fruit globose, 2-3 inches in diameter, containing fertile seeds; leaves of submerged seedlings triangular-ovate with acute lobes; primary floating leaves oval-sagittate, lobes acute, sinus open to center, green, paler beneath; mature leaves broadly oval-sagittate, peltate, margins irregularly undulate, lobes overlapping about one-third from the center of the leaf, occasionally forming a raised keel, the remaining two-thirds gradually diverging, 18 inches long, 15 inches broad, above pea-green, faintly spotted with reddish-brown when young, beneath paler green; petioles brown, attaining a length of 6 feet when fully developed.

Var. *marmorata* — Flowers cup-shaped, smaller than type, and with fewer petals; tips of the sepals and petals fading to pink; bud green striped with purple; peduncle green; leaves pea-green above, irregularly marmorated with reddish-brown, gradually fading out with age, lighter green faintly spotted with purple beneath; petioles green.

NEW HYBRIDS OF VIVIPAROUS CHARACTER

Amateur gardeners find it extremely difficult to carry the non-viviparous hybrids over the dormant period during the winter, and prefer the viviparous types because of the ease of propagation. In the latter the young rooted plants grow upon the parent leaves. These are easily removed and when potted will winter over in an ordinary fish aquarium, furnishing new plants for the next season's display.

Up to the present time only four really viviparous waterlilies have been in the trade, and all were in shades of blue. Since 1930 numerous pollinations have been made, using viviparous hybrids of *N. micrantha* parentage crossed with the yellow *N. Burttii*. The result has been strong viviparous hybrids in the following colors: white, cream, yellow, light blue, violet, and light pink, with the same color variation as the non-viviparous types.

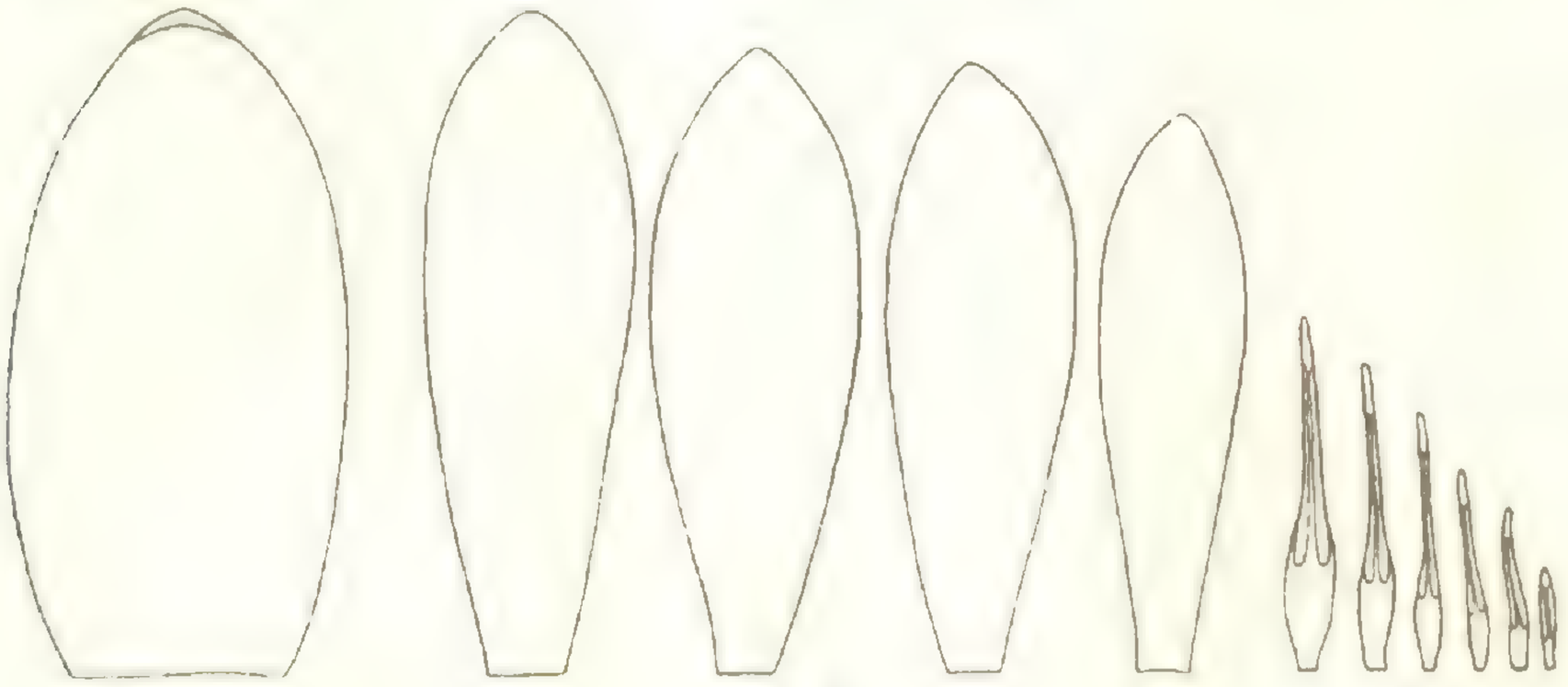
The following hybrids described are all from the original reciprocal crosses between *N. Burttii* and *N.* "Independence" (introduced by Tricker), which are the only parents resulting in a reciprocal fertile cross. *Nymphaea Burttii* as a pistillate parent produced M. B. G. 96, M. B. G. 104 violet, M. B. G. 104 pink, and M. B. G. 162, whereas as a staminate

parent it resulted in M. B. G. 147. In a subsequent number of the BULLETIN, which will take up the pollination of Nymphaeas, photographs of seed-pods will be given.

× NYMPHAEA M. B. G. 96 (BRACHYCERAS), PRING

N. Burttii ♀
×
N. "Independence" ♂
—M. B. G. 81 light blue ♀
×
M. B. G. 81 light blue ♂
—M. B. G. 96, Pring (1933)

This cream-colored ("sea-foam," according to Ridgway) hybrid is the outstanding seedling of the viviparous group. In size and number of sepals the flowers resemble those of the Lotos group. Other distinguishing characters are shape of the leaves, the absence of any spots or markings on them, and the pea-green color of the leaves and buds. It is readily propagated from the young plants developed from the center of the leaf.

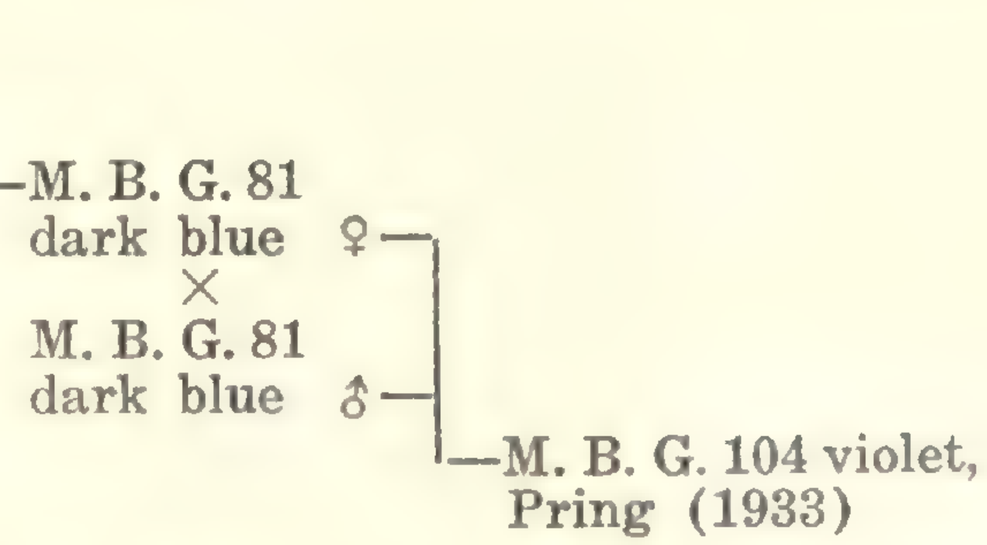


M. B. G. 96: S., sepals; P., petals; St., stamens. About ⅝ natural size.

Description — Flowers 10-12 inches across; bud broadly ovoid, light green; peduncle light green; sepals ovate, promi-

nently hooded at the apex, 4 inches long, 2 inches wide, green margined with yellow without, sea-foam yellow within, showing 12 nerves; petals 35-40, sea-foam yellow, comprising five rows, the outermost 4 inches long, 1½ inches wide, light green margined with sea-foam yellow without, yellowish-green at the base within, 6–7-veined; stamens 230-240, outermost row 2 inches long, sea-foam yellow tipped with lemon-chrome; carpels 40-45, the styles lemon-chrome; fruit globose, 2-3 inches in diameter, containing fertile seeds; mature leaves orbicular-sagittate, peltate, irregularly sinuate-undulate margins, 16 inches in diameter, sinus closed, the lobes forming a prominent keel, above light green, viviparous at the insertion of the petiole, beneath lighter green; petioles light green.

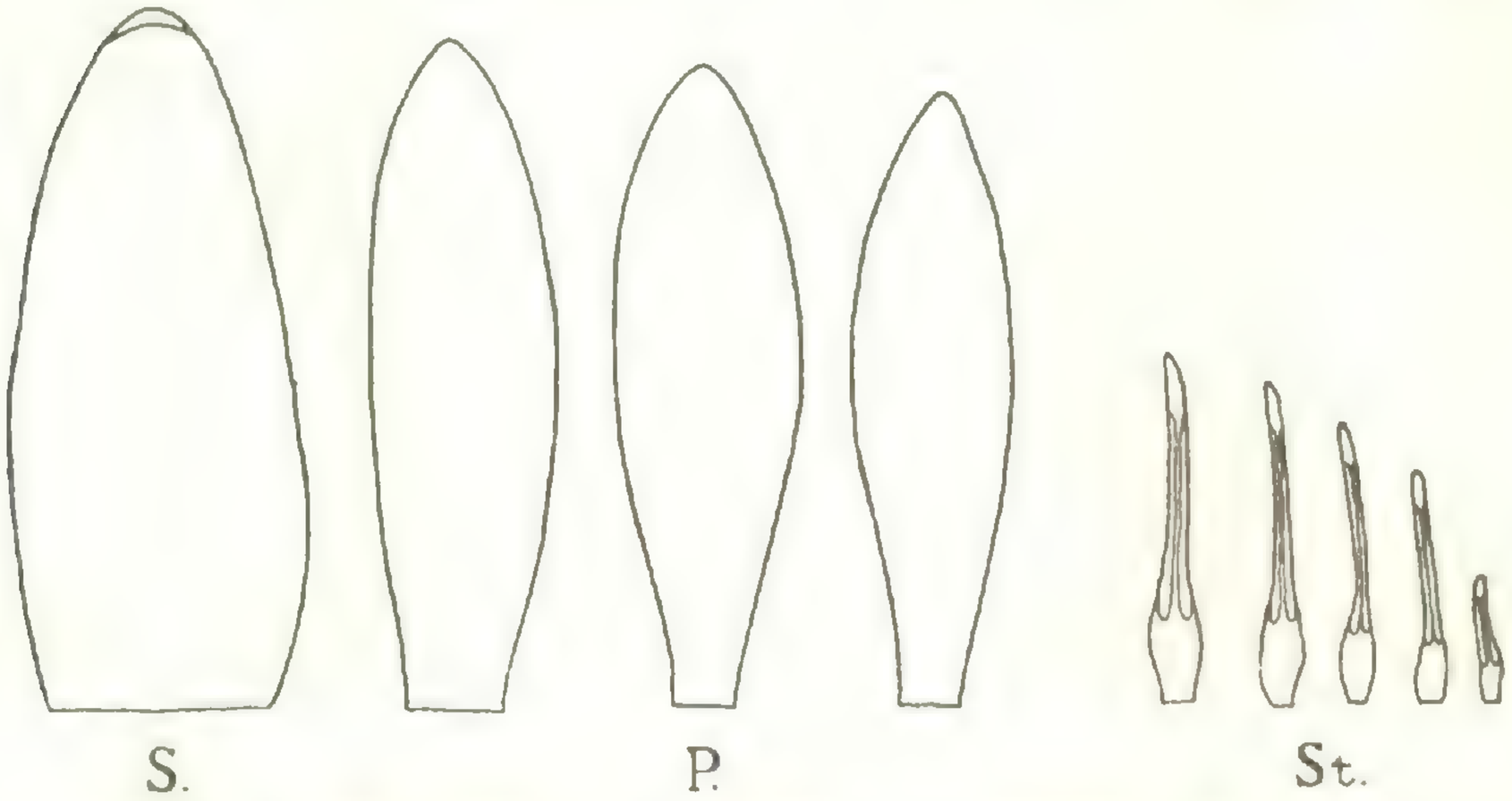
× NYMPHAEA M. B. G. 104 VIOLET (BRACHYCERAS), PRING



The small flowers of this plant might be explained by the fact that it is inclined to grow from several crowns. The flowers are the darkest of any raised at the Garden. The leaves are spotted with reddish-brown above, but there are no markings beneath. On account of the color and size of the flowers, this is a good plant for small pools. Young plants are produced from the center of the leaves.

Description — Flowers 7-8 inches across; bud ovoid-oblongoid, dark green; peduncle brown; sepals ovate, prominently hooded at the apex, 3¼ inches long, 1¼ inches wide, green margined with violet without, pallid violet within, showing 10-12 nerves; petals 38-40, pallid violet, comprising 4 rows, the outermost 3¼ inches long, ⅞ inch wide, without

striped with green along the median vein and at the base, 6-veined; stamens 190-200, lemon-chrome, outermost row 1½ inches long, pallid violet at the tips, anthers darker in color without; carpels 25-30, the styles lemon-chrome; fruit 1½-2 inches in diameter, containing fertile seeds; mature leaves



M. B. G. 104 violet: S., sepals; P., petals; St., stamens. About ½ natural size.

broadly oval-sagittate, peltate, margins irregularly undulate, 14 inches in diameter, sinus open one-third from center, above dark green spotted with reddish-brown, viviparous at the insertion of the petiole, beneath purplish-blue, venation light green; petioles brown.

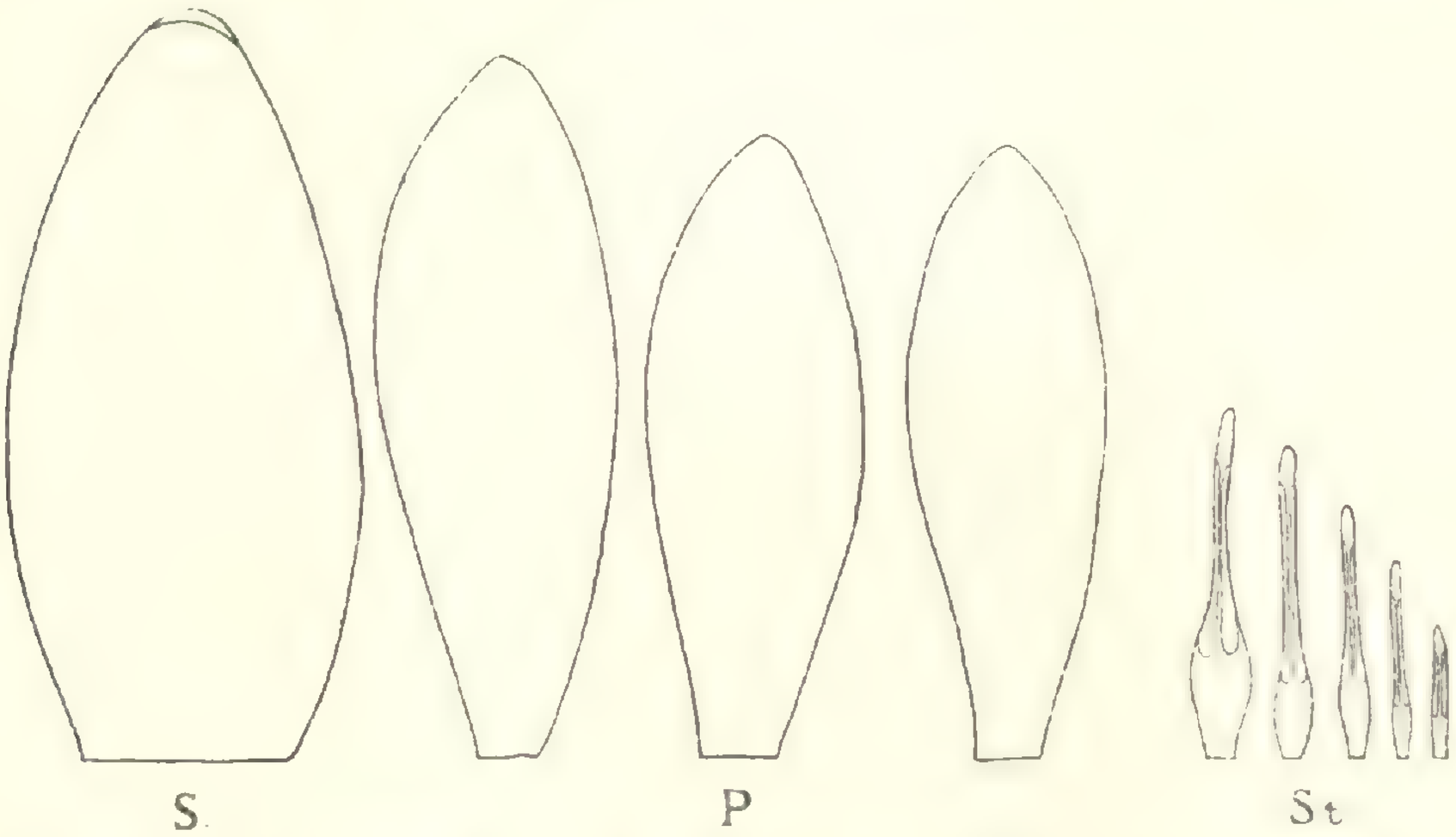
× NYMPHAEA M. B. G. 104 PINK (BRACHYCERAS), PRING

N. Burttii ♀ × _N._ "Independence" ♂ — M. B. G. 81

dark blue ♀ × M. B. G. 81 dark blue ♂ — M. B. G. 104 pink, Pring (1933)

The flowers of this hybrid resemble "General Pershing" in size and shape, but they are paler in color. The leaves are conspicuously blotched with reddish-brown above and are reddish-pink beneath. Young plants are produced rather sparingly from the center of the leaves.

Description — Flowers 10-12 inches across; bud ovoid, light green; peduncle brown; sepals ovate, slightly hooded at the apex, 4 inches long, 1¾ inches wide, light green margined with pink without, within pale rhodonite-pink, light green toward the base, showing 12 nerves; petals 30-35, pale



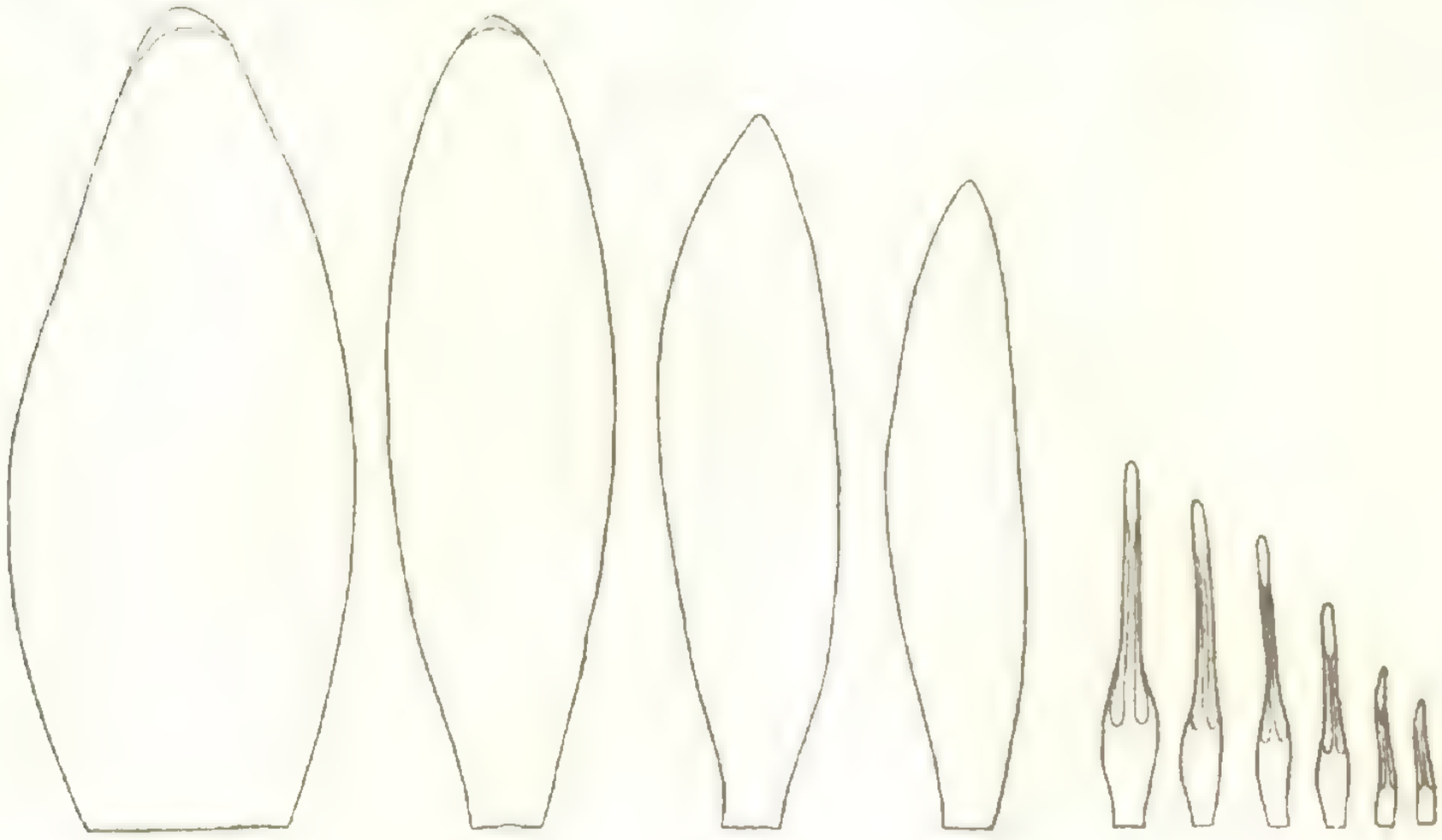
M. B. G. 104 pink: S., sepals; P., petals; St., stamens. About ½ natural size.

rhodonite-pink, comprising 4 rows, the outermost 3¾ inches long, 1¼ inches wide, light green toward the base without, 7-veined; stamens 280-290, pale lemon-yellow tipped with pink, becoming darker on the anthers, outermost row 2 inches long; carpels 35-40, with styles lemon-chrome; fruit sub-globose, 2-3 inches in diameter, containing fertile seeds: mature leaves orbicular-sagittate, margins irregularly undulate-sinuate, about 14 inches in diameter, sinus open one-third from center, above dark green spotted with reddish, venation light green, viviparous at the insertion of the petiole, reddish beneath; petioles brown.

× NYMPHAEA M. B. G. 147 (BRACHYCERAS), PRING

N. "Independence" ♀ —
×
N. Burttii ♂ —
—M. B. G. 13
dark blue ♀ —
×
M. B. G. 7
light blue ♂ —
—M. B. G. 147, Pring
(1933)

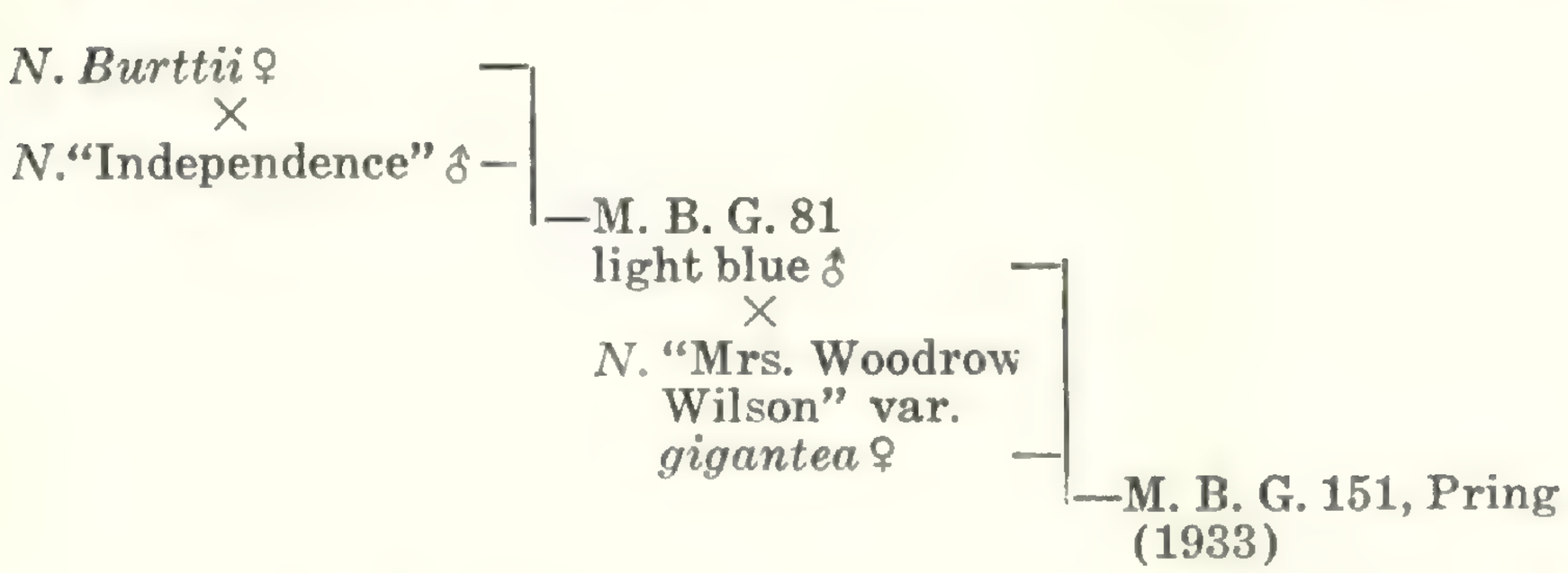
The flowers of this lily present an interesting anomaly. In all other Nymphaea flowers the stamens are yellow tipped at the apex with the same color as the petals. However, in this hybrid with the advent of cooler nights, in September, the yellow stamens change to a deep pink, and in cooler climates this character is permanent. The only defect of the plant is that during extremely hot weather the flowers become splotched with brown after several days. It is readily propagated from the plants at the center of the leaves.



M. B. G. 147: S., sepals; P., petals; St., stamens. About ½ natural size.

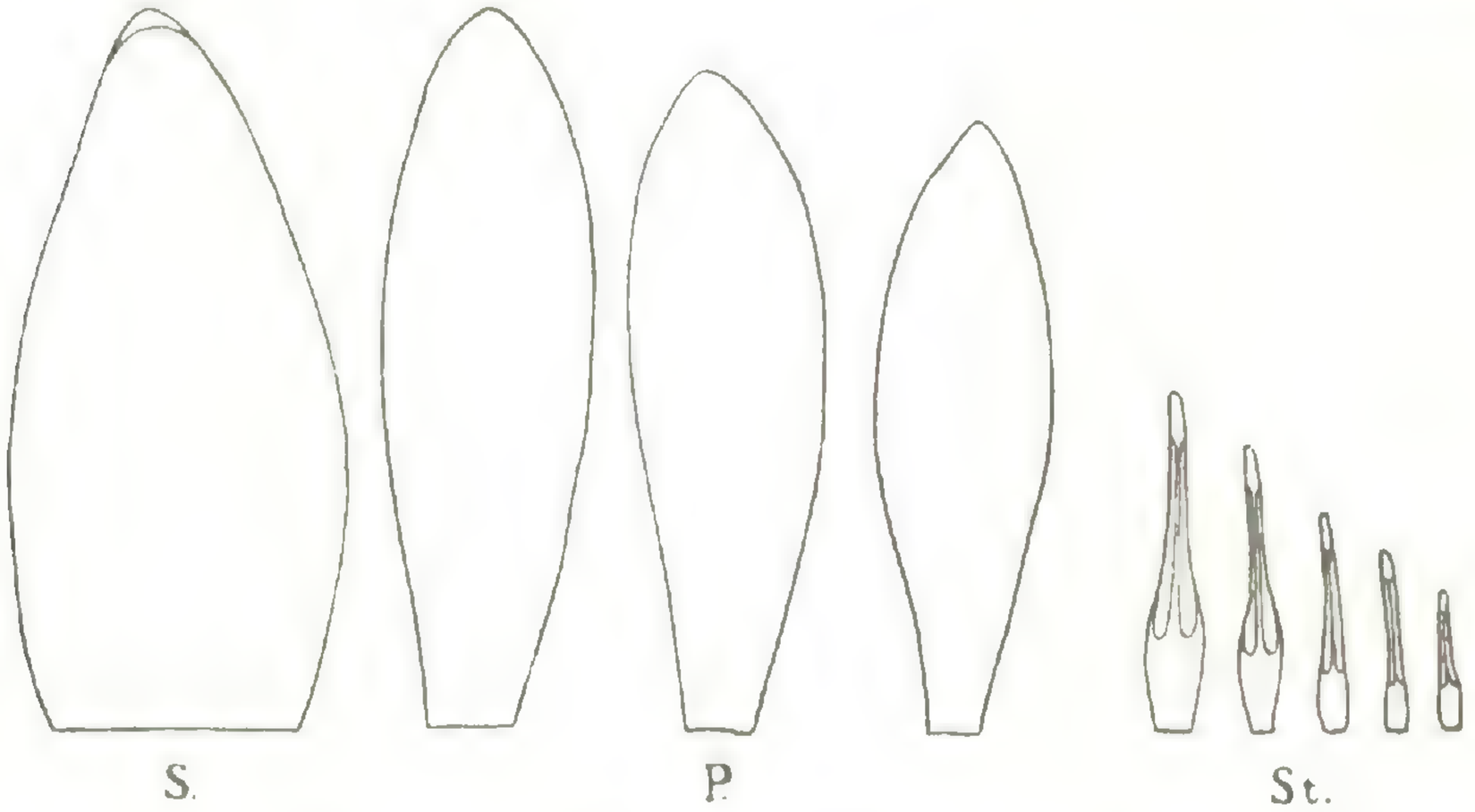
Description — Flowers 10-12 inches across; bud narrowly ovoid-conical, light green; peduncle brownish-green; sepals ovate, prominently hooded at the apex, 4½ inches long, 2 inches wide, green margined with white without, within white, green at the base, showing 14-16 nerves; petals 26-30, white, comprising 4 rows, the outermost occasionally notched and corrugated, slightly hooded, 4½ inches long, 1¼ inches wide, without striped with green along the median vein and at the base, 6–8-veined; stamens 240-250, outermost row 2 inches long, lemon-chrome tipped with white, later turning pink; carpels 35-40, the styles lemon-chrome; fruit subglobose, 2-3 inches in diameter, containing fertile seeds; mature leaves broadly oval-sagittate, peltate, margins irregularly undulate-sinuate, 15 inches in diameter, sinus open about one-third from center, later entirely open, above dark green with reddish-brown gradually fading out with age, viviparous at the insertion of the petiole, beneath light green; petioles brownish-green.

× NYMPHAEA M. B. G. 151 (BRACHYCERAS), PRING



Despite its *Burttii* parentage this hybrid shows no *Burttii* characteristics. Its leaves and its viviparous character are typical of "Mrs. Woodrow Wilson" var. *gigantea*. In shape the flowers resemble those of "Independence," but their color is like "Henry Shaw." Mr. J. C. Cutak, water-lily propagator at the Garden, refers to this plant as "The Best Wilson." It is easily propagated from the plants at the base of the leaves.

Description — Flowers 8-10 inches across; bud ovoid, dark green suffused with purple; peduncle brown; sepals ovate, prominently hooded at the apex, 4 inches long, 2 inches wide, outer surface dark green suffused with purple, blue toward the margins, within pale forget-me-not blue, light



M. B. G. 151: S., sepals; P., petals; St., stamens. About ½ natural size.

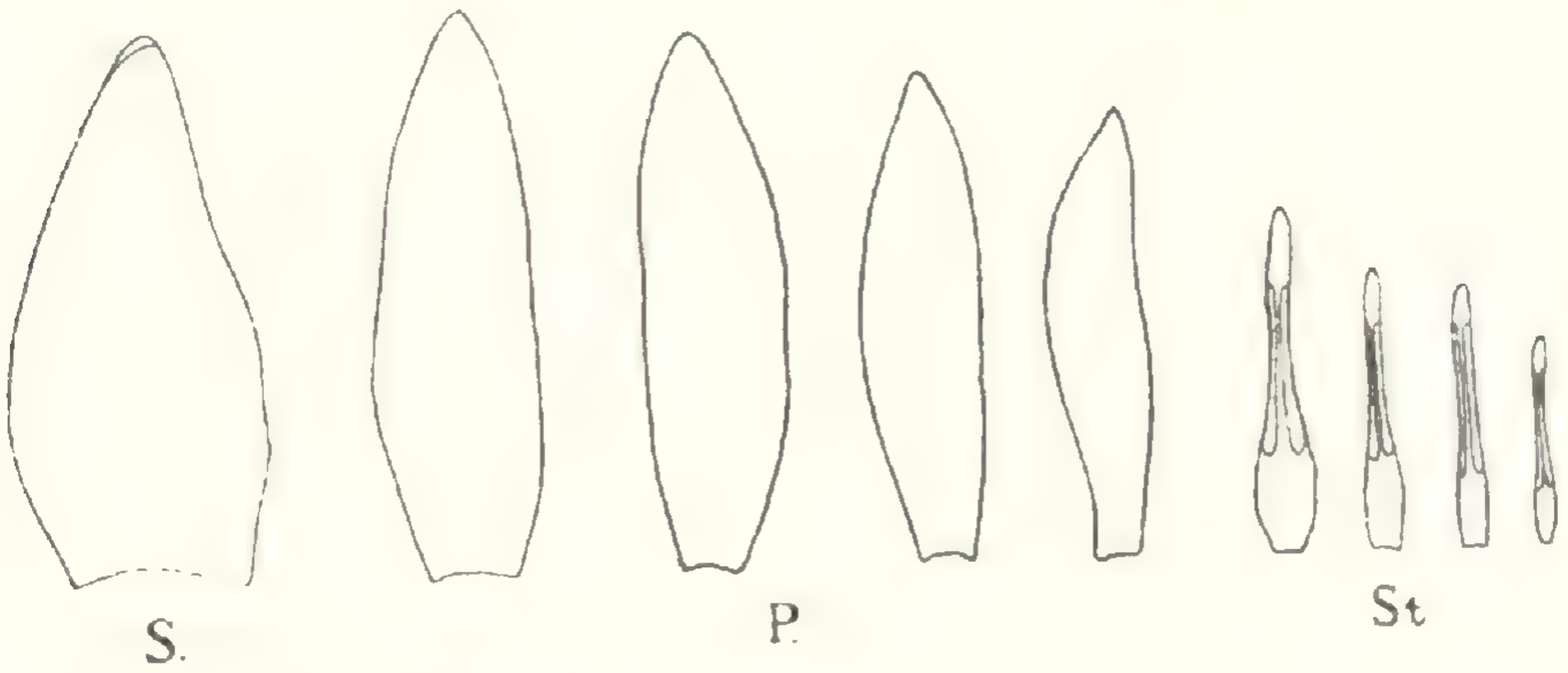
green at the base, 8–10-nerved; petals 24-28, pale forget-me-not blue, comprising 4 rows, the outermost 3½ inches long, 1¼ inches wide, without suffused with purple and blue as in the sepals, 6–7-veined; stamens 170-180, outermost row 1¾ inches long, lemon-chrome tipped with pale blue, becoming deeper in color toward the base; carpels 25-28, the styles lemon-chrome; fruit sub-globose, 2-3 inches in diameter, containing fertile seeds; mature leaves broadly oval-sagittate, peltate, margins irregularly undulate-sinuate, sinus open, about 14 inches in diameter, above brownish-green sparsely spotted with dark purple, becoming darker green with age, viviparous at the insertion of the petiole, beneath purplish-brown with prominent green venation; petioles brown.

× NYMPHAEA M. B. G. 162 (BRACHYCERAS), PRING

N. Burttii ♀
×
N. "Independence" ♂ —┐
├—M. B. G. 81
cream ♀ —┐
×
M. B. G. 81
cream ♂ —┘
└—M. B. G. 162, Pring (1933)

This was the first yellow viviparous Nymphaea to flower. On the first day of opening the petals and stamens were light green-yellow tipped with blue but later the blue and green faded out entirely. The flowers are smaller than those of M. B. G. 96, the plant being well adapted to small pools. It is readily propagated from the young plants produced at the center of the leaves.

Description — Flowers 8-10 inches across; bud ovoid, light green; peduncle brown; sepals ovate, prominently hooded at



M. B. G. 162: S., sepals; P., petals; St., stamens. About ⅓ natural size.

the apex, 3½ inches long, 1½ inches wide, green margined with yellow without, within light green-yellow, green at the base, showing 14-16 nerves; petals 25-30, green-yellow, comprising 4 rows, the outermost lanceolate, acute, slightly

hooded, 3½ inches long, 1 inch wide, without margined with yellow, 6–8-veined; stamens 210-220, outermost row 1½ inches long, pale green-yellow, lemon-chrome at the base; carpels 30-35, the styles lemon-chrome; fruit sub-globose, 2-2½ inches in diameter, containing fertile seeds; mature leaves broadly oval-sagittate, peltate, margins irregularly undulate, sinus open one-third from the center at first, later entirely open, 15 inches in diameter, above dark green with reddish-brown spots fading out with age, viviparous at the insertion of the petiole, beneath flushed with purple; petioles brown.

The March BULLETIN will continue the discussion of Nymphaeas, including their cultivation and methods of pollination and propagation.

G. H. P.

NOTES

Mr. G. H. Pring, Superintendent of the Garden, has been elected president of the St. Louis Florists' Club, and has been re-elected president of the St. Louis Horticultural Society, for 1934.

Mr. Paul A. Kohl, Floriculturist to the Garden, spoke before the St. Clair Garden Club, Signal Hill, Ill., January 18, on "The Rock Garden"; and before the Webster Groves Home Garden Club, January 26, on "Spring Gardening."

Mr. L. P. Jensen, Manager Missouri Botanical Garden Arboretum, gave a talk before the members of the Alhambra Grotto Wednesday Dinner Club, January 24, on "Henry Shaw and the Missouri Botanical Garden"; and before the Garden Club of Sullivan, Mo., February 6, on "Planning and Planting the Garden."

Dr. S. M. Zeller, professor of plant pathological research, Oregon State College, Corvallis, with the aid of a grant from the Science Research Fund, is spending several months at the Shaw School of Botany, collaborating with Dr. C. W.

Dodge, Mycologist to the Garden, on a monograph of the Hymenogastraceae.

The "Garden Digest" for January, 1934, contains photographs of the "before" and "after" gardens at the Missouri Botanical Garden, also a condensation of the article from "Parks and Recreation" on "Identifying Woody Plants in Winter," by Mr. L. P. Jensen, Manager Missouri Botanical Garden Arboretum.

Recent visitors to the Garden include Dr. Francis Drouet, assistant, and Mr. L. Jeffrey, student, department of botany, University of Missouri, Columbia; Dr. Hans Kopf and Dr. A. Elschnig, of Marienbad, Czechoslovakia; and Miss Esther Adams, instructor in botany, Moberly Junior College, Moberly, Mo., accompanied by the class in botany from that institution.

Dr. Hermann von Schrenk, Pathologist to the Garden, gave a talk on "Termites and Methods for Combating Them," January 24, at the Rice Hotel, Houston, Texas, before a joint meeting of the Houston Engineers' Club, South Texas chapter of the American Institute of Architects, Rice Institute Engineering Society, and the American Wood Preservers' Association; and on January 25 he presented a paper before the annual meeting of the American Wood Preservers' Association, at Houston, entitled "Opportunities for Marketing Ready-to-Use Treated Material."

Mr. G. H. Pring, Superintendent of the Garden, gave an illustrated lecture before the Gray Summit Garden Club, January 8, on "City Gardens"; before the Des Moines Garden Club, Des Moines, Iowa, January 15, on "The Cultivation and Breeding of Water-lilies"; before the Federation of Improvement Associations of St. Louis, January 26, on "Plant Curiosities"; before the Practical Arts Club of College Women, February 16, "Annuals and Perennials."

STATISTICAL INFORMATION FOR JANUARY, 1934

GARDEN ATTENDANCE:

Total number of visitors..... 11,417

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought..... 82
Total number of books and pamphlets donated..... 163

PLANT ACCESSIONS:

Total number of plants and seed packets donated..... 83

HERBARIUM ACCESSIONS:

By Purchase—

Bush, B. F.—Plants of Kansas collected by Dr. Frank C. Gates 250
Lundell, C. L.—Plants of British Honduras..... 86
Migula, W.—"Cryptogamae Germaniae, Austriae et Helveticae exsiccatae," fasc. 56-62 inclusive..... 175
University of Notre Dame—Photographs of type specimens in the Greene Herbarium..... 2
Verdoorn, Fr.—"Hepaticae selectae et criticae," Series VII, Nos. 301-350 inclusive..... 50
Weigel, Theo. Oswald—Plants of Chile..... 170

By Gift—

Bailey, L. H.—Photograph of *Vitis vulpina* var. *praecox* Bailey 1
Bush, B. F.—Plants of the United States..... 13
Lahman, Mrs. Charles E.—Photographs of cacti..... 5
Zeller, S. M.—Plants of Oregon..... 2

By Exchange—

Bernice P. Bishop Museum—Plants of the United States, collected by Dr. Harold St. John..... 192
Brooklyn Botanic Garden — Plants of eastern United States 80
Field Museum of Natural History—Plants of Hawaii... 43
Hermann, F. J.—Plants of eastern United States and California 130
New York Botanical Garden — Plants of New York, Maine, etc..... 156
Pomona College by Dr. P. A. Munz—Plants of California, Oregon, etc..... 250
U. S. National Herbarium—Plants of Arizona and California collected by W. W. Eggleston..... 99
University of Missouri—Plants of Missouri..... 106

Total 1,810

SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date to the death of Mr. Shaw, in 1889, the Garden was maintained under the personal direction of its founder, and, while virtually a private garden, it was, except at certain stated times, always open to the public. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was designated by Mr. Shaw as its official title and in his will or in any of his writings he specifically referred to it as the "Missouri Botanical Garden." By a provision of Mr. Shaw's will the Garden passed at his death into the hands of a Board of Trustees. The original members of the Board were designated in the will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will, the immediate direction of the Garden is vested in a Director, appointed by the Board of Trustees. The Garden receives no income from city or state, but is supported entirely from funds left by the founder.

The city Garden comprises 75 acres, where about 12,000 species of plants are growing. There is now in process of development a tract of land of over 1,500 acres outside the city limits which is to be devoted to (1) the propagation and growing of plants, trees, and shrubs, designed for showing either indoors or outside, at the city Garden, thus avoiding the existing difficulties of growing plants in the city atmosphere; (2) gradually establishing an arboretum as well as holding a certain area as a forest reservation, with the idea that possibly at some future time this may become the new botanical garden.

The Garden is open to the public every day in the year, except New Year's Day and Christmas—week days from 8:00 a. m. until one-half hour after sunset; Sundays from 10 a. m. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Place, on the Sarah car line (No. 42). Transfer south from all intersecting lines. The Garden may also be reached by Bus Route No. 12, to which all other motor-bus lines transfer.

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MISSOURI BOTANICAL GARDEN BULLETIN

Vol. XXII MARCH, 1934 No. 3

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NYMPHAEA BLUE: THE POLLEN PARENT N. "MRS. GEORGE H. PRING," THE SEED PARENT, AND N. ST. LOUIS, THE OFFSPRING.

Missouri Botanical Garden Bulletin

Vol. XXII MARCH, 1934 No. 3

HYBRID NYMPHAEAS—THEIR CREATION, PROPAGATION AND CULTIVATION

The February Bulletin (Vol. 22, No. 2) gave the history and description of the various hybrid nymphaeas which have been created at the Garden. In order that those interested may be able to carry on similar work it has seemed desirable to give details concerning the various operations involved in creating hybrid water-lilies, with additional information as to methods of propagation and cultivation.

Culture.—The first consideration for growing water-lilies is the construction of a pool. A natural pool may be easily constructed by digging it in a low place in the garden exposed to full sunshine, or a concrete basin may be built. The size of the pool should be governed by the plan of the garden. A pool six or eight feet in diameter will accommodate a maximum of three water-lilies; overcrowding spoils the effect of the water garden. In any case there should be at least a foot of water above the planting level, while a foot and a half is better for hardy lilies in order to prevent possible freezing in winter. If the pool must be drained in winter, the roots of the hardy lilies should be covered with a thick

layer of straw or manure, or if they have been planted in boxes the plants should be removed to a cool cellar.

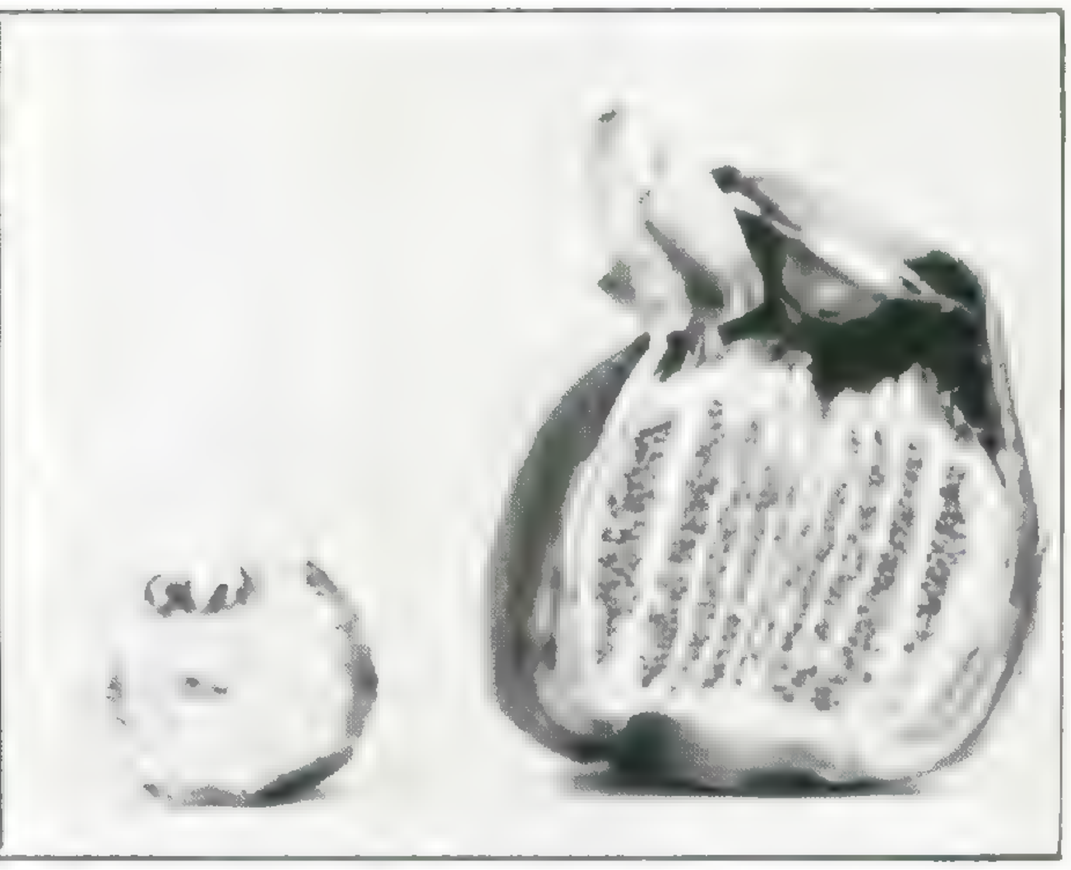
Water-lilies, especially the tropical varieties, are rank feeders, and a liberal supply of fertilizer is essential. Where the subsoil will permit making of natural ponds, the soil should be well fertilized before planting. When concrete ponds have been built, two inches of manure should be spread over the bottom, and ordinary sod soil added to a depth of eight inches. An objection is that the water becomes discolored and may remain so if agitated by the movement of fish in the pool. Planting the lilies in boxes two to three feet square and a foot deep and placing them on the bottom of the pool is the simplest method of culture for the amateur. Frequently half-barrels are used.

The hardy lilies need less attention than the tropical ones. Their growth is from continuous thickened roots or rhizomes which subdivide, and for this reason the plants must be confined to a restricted area and transplanted every four years. When grown in small boxes, fresh soil should be added at the time of removal. The rhizomes should be planted in early spring about two to three inches deep, the growing portion being level with the top of the soil.

The tropical lilies are more fascinating to grow, especially when a pool is planted with both night- and day-bloomers. Unless heated tanks in a greenhouse are available during the winter, the tropical varieties should be treated by the amateur as annuals. Their magnificent blooms during the summer will more than justify the moderate cost of replacing them each year. The time of planting depends upon the locality. It must be remembered that the purchased plants have been wintered in water at a mimimum temperature of 70° F. and are susceptible to chilling in cooler water, resulting in their "going to sleep" or becoming dormant. In St. Louis the lilies should not be planted until after May 15, when the temperature of the water should be at least 70° F. The plants should be set with the crown just below the surface of the soil. As the lilies grow the water should be raised until it is a foot above the roots. By July 1 the plants start to flower with remarkable regularity, and continue until killed back by frost, usually in October.

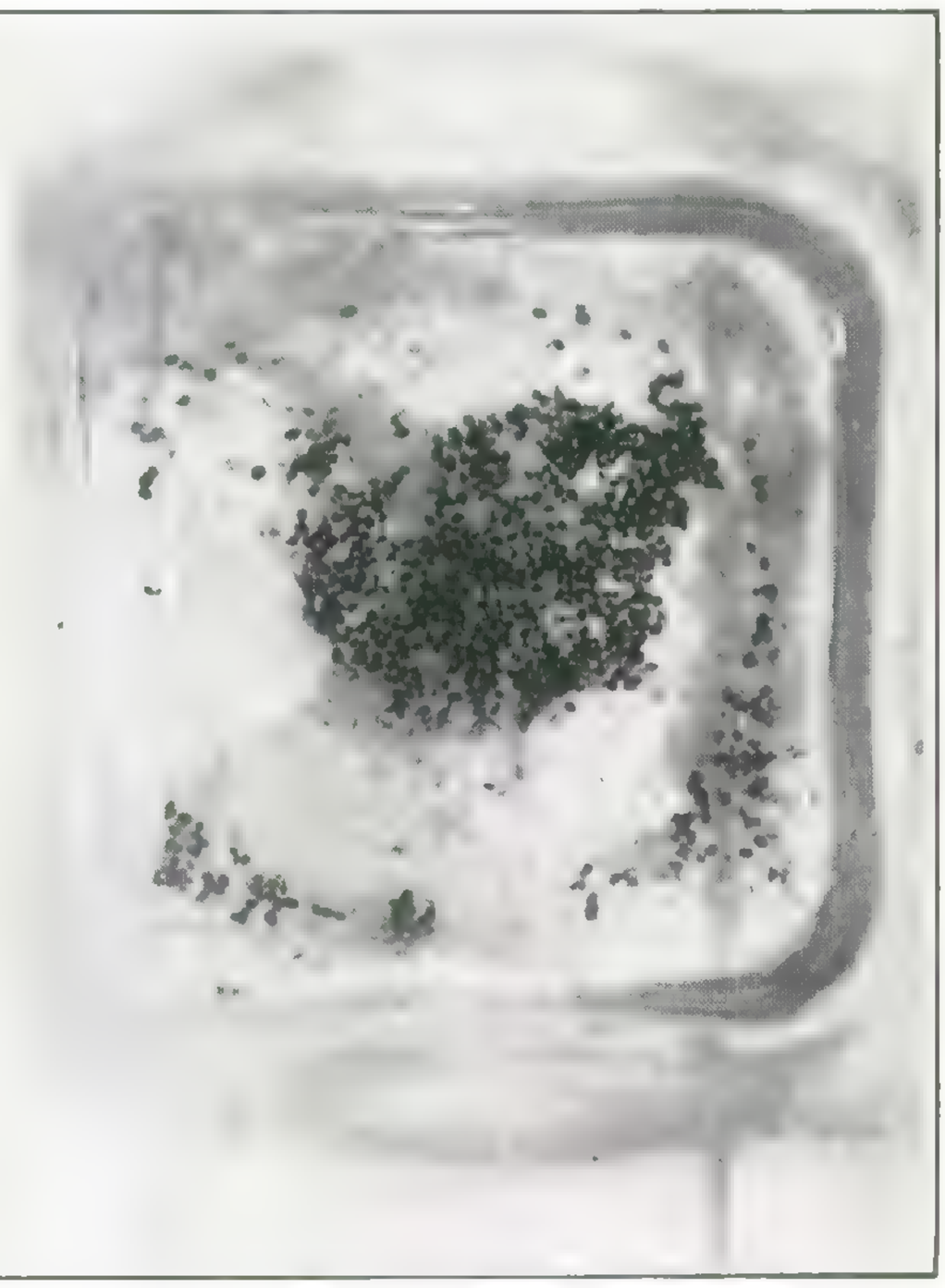
1. EQUIPMENT FOR POLLINATION. 2. PREPARING BUD FOR POLLINATION. 3. REMOVING STAMENS FROM SEED PARENT. 4. POLLINATION.

1.
TYING POLLINATED
FLOWER TO A STAKE.



2.
SEED-POD OF RECIPROCAL
CROSSES, N. BURTTII (LEFT)
AND N. "INDEPENDENCE" (RIGHT).

3.
RIPENING SEEDS.



4.
RIPENED SEEDS SUNK
TO BOTTOM OF JAR.

PROPAGATION

There are three methods by which the grower may increase his plants: (1) by seed, (2) by leaf propagation (viviparous types only), and (3) by tubers.

1. *Seeds.*—Seeds should be used only in creating new forms or perpetuating new species. When pollinated by insects the flowers are rarely ever produced true to type, and artificial pollination must be resorted to. The materials and equipment for artificial pollination are shown in plate 27, fig. 1.

Two days previous to the pollination the parent flower buds are selected and fastened with a rubber band to prevent further opening (pl. 27, fig. 2). First, however, the bud which is to be the seed parent is forced open and all the stamens removed (pl. 27, fig. 3). Care must be taken that the bud is in the right stage, with no trace of nectar in the cup-shaped stigma. After the removal of the stamens the bud is closed and fastened securely with a rubber band, one loop of which should be placed around the upper portion and another loop around the rounded portion. On the day of pollination the stamens should be removed from the pollen parent bud, using forceps which have been sterilized in alcohol (the large bottle and one small vial illustrated in pl. 27, fig. 1, contain the alcohol) and at least six of the stamens placed in the small vial. The vial should be closed immediately with a rubber stopper to prevent insects from entering, and the forceps should be dipped in the alcohol after each flower.

The next operation is to open the seed flower. If it is filled with nectar it has reached the receptive period; if not the time is premature or past, and another flower should be selected. With the use of sterilized forceps the stamens with attached pollen should be withdrawn from the vial and placed in the cup-shaped stigma (pl. 27, fig. 4). For the best results the time of crossing is limited to the first day of the flower's opening, between 10 A. M. and noon. The stamens are erect on the first day of opening, exposing the stigma; the second day they are inflexed, covering the dry stigma; and the fourth day they are reflexed and again the stigma is exposed. In a natural pollination as many as six insects

may be seen, which have pollinated the flower and become drowned in the nectar.

Care must be taken during the operation that no bees are flying around the flower, as there is danger that they will drop minute pollen grains into the nectar and spoil the work. After pollination the flower should be closed again, fastened with double rubber bands, and wrapped with fine gauze which should be securely tied below the rounded portion of the flower bud. The celluloid label (pl. 27, fig. 1), marked with pollination number, date, and parents, should then be attached.

When the flower has been wrapped it should be tied to a stake, the string being left long enough to permit the natural lowering under the water for seed development (pl. 28, fig. 1). The pod will ripen in about three weeks, when it will again rise to the surface of the water, and unless it has been wrapped with muslin, the natural dehiscence will have broadcast the seeds over the surface of the pond. Further ripening is necessary to disintegrate the fleshy covering, this being accomplished by placing the seed in a battery jar of water for three or four days (pl. 28, fig. 3). Virile seeds, when ripened fully, sink to the bottom of the container (pl. 28, fig. 4). In order to prevent premature germination, they should be removed from the water and dried for two or three days.

When the seeds separate readily, they may be immediately sown in sandy soil in shallow pans, or, more conveniently, in ordinary glass battery jars which are half filled with soil. The seeds should be broadcast evenly, barely covered with finely sieved sand, and the soil firmed gently to prevent seed from floating while jar is being filled with water. The jars may then be placed in the heated tanks at a temperature of 75-80° F. As soon as the seedlings develop floating leaves they may be transplanted into small pots for further development.

2. *Leaf propagation.*—This method is restricted to viviparous hybrids. *Nymphaea* "Mrs. Woodrow Wilson" var. *gigantea*, M. B. G. 96, M. B. G. 104 violet and pink, M. B. G. 147, M. B. G. 151, and M. B. G. 162, described in the February BULLETIN, are all of the viviparous type. The young

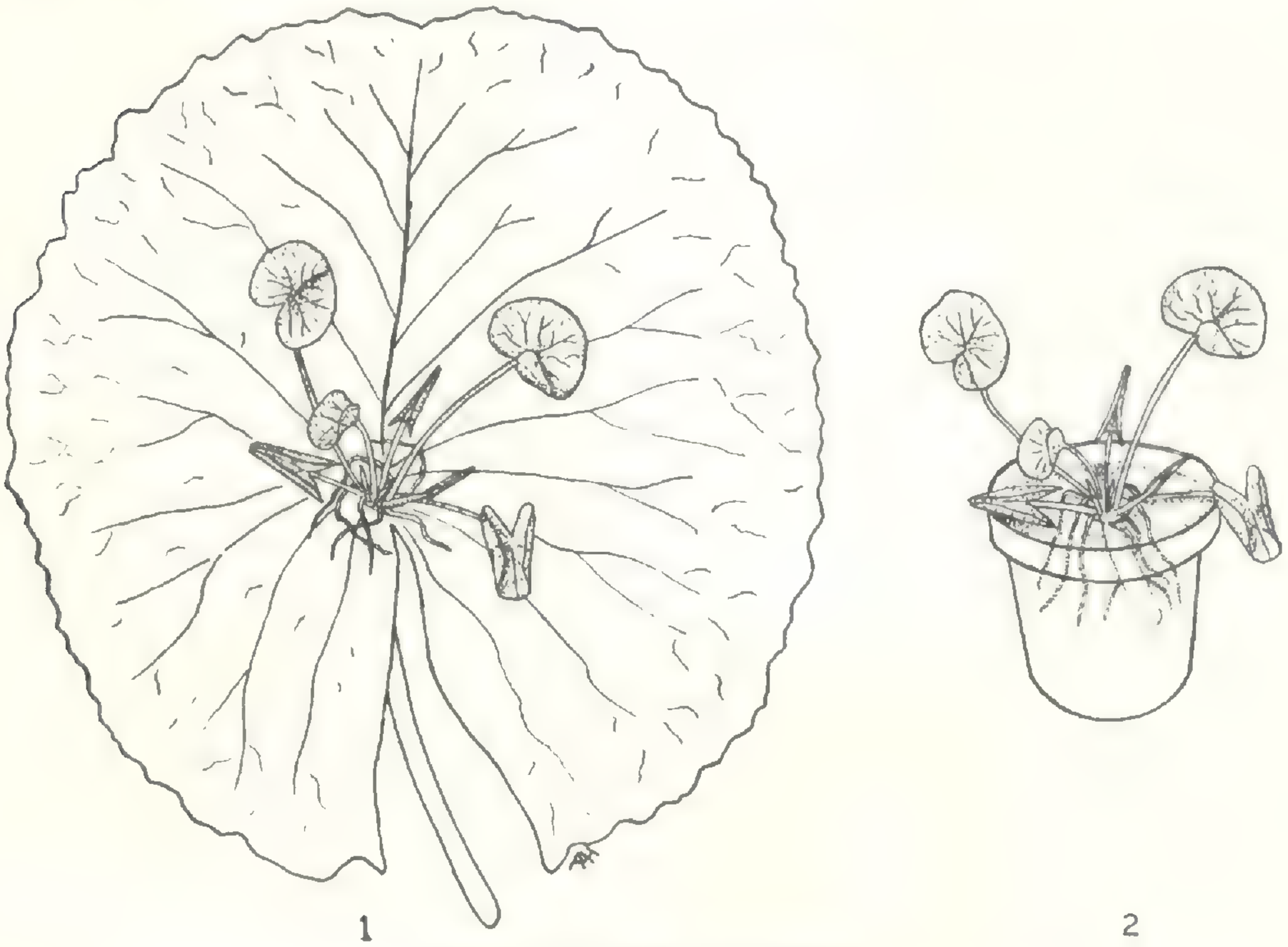
NYMPHAEA KEWENSIS, KEPT DORMANT IN SAND FOR FOUR YEARS, SHOWING SLIGHT SHRIVELLING.

SAME TUBERS AFTER BEING KEPT IN THE PROPAGATING TANK FOR THREE WEEKS, SHOWING ROOTED SHOOTS (ON THE LEFT) READY TO BE SEGREGATED FROM TUBER.

SMALL PROPAGATING TUBER OF NYMPHAEA "ST. LOUIS" (LEFT), KEPT DORMANT IN SAND FOR THREE YEARS; PARENT TUBER (RIGHT), SHOWING YOUNG TUBER FORMING AT BASE.

PARENT TUBER OF DAY-BLOOMING NYMPHAEA (LEFT), SHOWING FORMATION OF NEW TUBER AT BASE, PARENT TUBER OF NIGHT-BLOOMER (RIGHT), SHOWING MANY YOUNG TUBERS AT TOP AND BASE.

plants are produced from the leaf (fig. 1), and since they produce roots they are simply cut from the parent leaf and potted (fig. 2). Propagation is carried on from July until frost, when sufficient stock for the following summer may be established. If given room for good root growth, these will bloom during the winter.



1 2

VIVIPAROUS PROPAGATION

1. Showing production of young plants from center of leaf.
2. Young plants removed and potted.

3. *Tuber propagation.*—The non-viviparous lilies are increased by tubers only. The old tubers developed outside are of practically no use for propagation. In fact, it is a waste of labor to dig up the plants in the fall and transfer them to the greenhouse. When the young pot plants are planted in the outside ponds they possess a small tuber resembling a hickory nut (see pls. 29 and 30). During the summer the tuber grows until it attains the size of a medium-sized potato, and young tubers form at the base of the parent tuber. These furnish the propagating stock and may be

removed from the plant at the end of August or early in September.

It is best to give the bulbs a partial resting period before planting by placing them in sand for two or three weeks. Experience will teach the grower to store them in a tin container with top, since both rats and mice relish them as a delicacy. After the resting period, the tubers should be potted in sandy soil, being planted deep to induce a long root growth, and kept at a temperature of 80° F. The young leaves will appear within two weeks (see pls. 29 and 30). As soon as two floating leaves develop, dig into the soil with thumb and finger to locate the radical or stem at the top of the tuber. Then pinch off the young plant with roots attached, just above the tuber, and pot immediately before it has had time to dry out. A good propagating tuber should yield at least twelve young plants before going to sleep. Best results are obtained with the pot-grown tubers, disregarding the outside plants. This applies to both the night- and day-bloomers of the tropical lilies. The hardy lilies, which possess a creeping rhizome, are easily propagated by division.

POLLINATION

The following charts comprise the Nymphaea crosses made at the Garden since the introduction of the yellow *N. Burttii* in 1930. The number of the cross, date of pollination, the parents (female parent first), and the fertility of the seed are given. In some cases only a few seeds were found in a seed-pods, in which case they are called "fertile," although often no germination resulted. The following abbreviations are used:

oval. g.=*ovalifolia gigantea*
Koch="August P. Koch"
Pan. Pac.="Panama Pacific"
Whit. g.="Mrs. Edwards Whitaker" var. *gigantea*
Stone="William G. Stone"
Persh.="General Pershing"
Indep.="Independence"
Pring="Mrs. George H. Pring"
Hitch.="Mrs. George C. Hitchcock"
Sturtev.=*Sturtevantii*
W. Wilson g. = "Mrs. Woodrow Wilson var. *gigantea*
Stella G.=Stella Gurney
Shaw=Henry Shaw
Hutch.=Emily Grant Hutchings
Haarst.=H. C. Haarstick
Eliot=Edward C. Eliot
Lotus g.=*Lotus gigantea*
Pan. white=Undetermined white species from Panama

NYMPHAEA "ST. LOUIS"
(*N. "Mrs. G. H. Pring" x N. Burrii*)

NYMPHAEA "MISSOURI"
N. "Mrs. George C. Hitchcock" x N. *Sturtevantii*

NYMPHAEA POLLINATIONS

Date of cross	No.	Cross	Date of seed collection	Seed Fertile	Seed Sterile
		1930			
June 17	1	*Burttii* x *Burttii*	July 2		+
Aug. 7	2	*oval. g.* x *Burttii*	Aug. 25	+	
Aug. 7	3	Koch x *Burttii*	Aug. 26		+
Aug. 7	4	Pan. Pac. x *Burttii*	Aug. 26	+	
Aug. 7	5	Shaw x *Burttii*	Sept. 2		+
Aug. 8	6	*oval. g.* x *Burttii*	Aug. 25		+
Aug. 8	7	Koch x *Burttii*	Aug. 30	+	
Aug. 8	8	Whit. g. x *Burttii*	Aug. 26	+	
Aug. 11	9	*oval. g.* x *Burttii*	Aug. 28		+
Aug. 11	10	Shaw x *Burttii*	Sept. 2	+	
Aug. 11	11	Stone x *Burttii*	Sept. 8	+	
Aug. 11	12	Persh. x *Burttii*	Aug. 29		+
Aug. 11	13	Indep. x *Burttii*	Sept. 8	+	
Aug. 11	14	Pring x *Burttii*	Sept. 2	+	
Aug. 11	15	Stella G. x *Burttii*	Sept. 2		+
Aug. 11	16	*Lotus g.* x *Burttii*	Aug. 28		+
Aug. 12	17	*oval. g.* x *Burttii*	Sept. 2		+
Aug. 12	18	Whit. g. x *Burttii*	Aug. 27		+
Aug. 12	19	Koch x *Burttii*	Aug. 27		+
Aug. 12	20	*Lotus g.* x *Burttii*	Aug. 28		+
Aug. 12	21	Pring x *Burttii*	Aug. 26		+
Aug. 12	22	Pring x *Burttii*	Aug. 28		+
Aug. 13	23	*Burttii* x *Burttii*	Sept. 1		+
Aug. 13	24	Pan. Pac. x *Burttii*	Aug. 28		+
Aug. 13	25	Persh. x *Burttii*	Aug. 27		+
Aug. 13	26	Stone x *Burttii*	Aug. 29		+
Aug. 14	27	Hitch. x *Sturtev.*	Sept. 5	+	
Aug. 15	28	Whit. g. x *Burttii*	Sept. 4	+	
Aug. 15	29	Pan. Pac. x *Burttii*	Sept. 8	+	
Aug. 15	30	Stella G. x *Burttii*	Sept. 4		+
Aug. 15	31	Stella G. x *Burttii*	Sept. 2		+
Aug. 15	32	Shaw x *Burttii*	Aug. 31	+	
Aug. 15	33	Pring x *Burttii*	Sept. 3		+
Aug. 15	34	Pring x *Burttii*	Aug. 31		+
Aug. 15	35	Persh. x *Burttii*	Sept. 3	+	
Aug. 15	36	Indep. x *Burttii*	Sept. 3	+	
Aug. 15	37	Pring x *Burttii*	Sept. 3	+	
Aug. 16	38	Koch x *Burttii*	Sept. 8		+
Aug. 16	39	Shaw x *Burttii*	Aug. 31		+

Date of cross	No.	Cross	Date of seed collection	Seed Fertile	Seed Sterile
Aug. 16	40	Stone x *Burttii*	Sept. 8	+	
Aug. 16	41	Whit. g. x *Burttii*	Sept. 8	+	
Aug. 16	42	Whit. g. x *Burttii*	Aug. 29		+
Aug. 16	43	Indep. x *Burttii*	Sept. 2	+	
Aug. 16	44	Pring x *Burttii*	Sept. 2	+	
Aug. 18	45	Whit. g. x *Burttii*	Sept. 3		+
Aug. 18	46	Persh. x *Burttii*	Sept. 5		+
Aug. 18	47	Persh. x *Burttii*	Sept. 2		+
Aug. 18	48	Koch x *Burttii*	Sept. 5	+	
Aug. 18	49	*Lotus g.* x *Burttii*	Aug. 29		+
Aug. 18	50	Stella G. x *Burttii*	Sept. 4		+
Aug. 18	51	Stella G. x *Burttii*	Sept. 4		+
Aug. 18	52	Stone x *Burttii*	Sept. 2		+
Aug. 18	53	Pring x *Burttii*	Sept. 6	+	
Aug. 18	54	*Burttii* x *Burttii*	Sept. 1		+
Aug. 19	55	*Burttii* x *Burttii*	Sept. 6	+	
Aug. 19	56	Indep. x *Burttii*	Sept. 6		+
Aug. 19	57	Pring x *Burttii*	Sept. 5	+	
Aug. 19	58	Stella G. x *Burttii*	Sept. 3		+
Aug. 19	59	Stone x *Burttii*	Sept. 14	+	
Aug. 20	60	Whit. g. x *Burttii*	Sept. 8	+	
Aug. 20	61	Pan. Pac. x *Burttii*	Sept. 6	+	
Aug. 20	62	Shaw x *Burttii*	Sept. 5	+	
Aug. 20	63	Pring x *Burttii*	Sept. 8	+	
Aug. 20	64	Indep. x *Burttii*	Sept. 13	+	
Aug. 22	65	*Burttii* x Koch	Sept. 6		+
Aug. 22	66	Persh. x *Burttii*	Sept. 11	+	
Aug. 22	67	*Lotus g.* x *Burttii*	Sept. 4		+
Aug. 22	68	Shaw x *Burttii*	Sept. 22	+	
Aug. 22	69	Pring x *Burttii*	Sept. 4	+	
Aug. 23	70	*Burttii* x *oval. g.*	Sept. 11		+
Aug. 23	71	*Burttii* x Pan. Pac.	Sept. 11		+
Aug. 23	72	Whit. g. x *Burttii*	Sept. 8		+
Aug. 23	73	Pring x *Burttii*	Sept. 8	+	
Aug. 23	74	Persh. x *Burttii*	Sept. 10	+	
Aug. 25	75	*Burttii* x Shaw	Sept. 11		+
Aug. 25	76	Whit. g. x *Burttii*	Sept. 8		+
Aug. 25	77	Persh. x *Burttii*	Sept. 11	+	
Aug. 25	78	*Lotus g.* x *Burttii*	Sept. 5		+
Aug. 25	79	Hutch. x *Sturtev.*	Sept. 12	+	
Aug. 26	80	Haarst. x *Sturtev.*	Sept. 12	+	
Aug. 27	81	*Burttii* x Indep.	Sept. 14	+	

Date of cross	No.	Cross	Date of seed collection	Seed Fertile	Seed Sterile
Aug. 30	82	*Burttii* x Persh.	Sept. 16		+
Sept. 1	83	*Burttii* x Pring	Sept. 22		+
Sept. 4	84	*Burttii* x Whit. g.	Sept. 22		+
Sept. 7	85	*Burttii* x Stone	Sept. 29		+
Sept. 12	86	*Burttii* x Stella G.	Oct. 2		+
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Aug. 11	87	14 yellow x *Burttii*	Sept. 3	+	
Aug. 11	88	W. Wilson g. x *Burttii*	Sept. 3		+
Aug. 12	89	14 yellow x *Burttii*	Sept. 3	+	
Aug. 12	90	81 dark blue x self.	Sept. 3		+
Aug. 12	91	8 yellow x *Burttii*	Sept. 3		+
Aug. 12	92	8 light blue x self.	Sept. 3		+
Aug. 12	93	14 yellow x self.	Sept. 5	+	
Aug. 12	94	W. Wilson g. x *Burttii*	Sept. 5		+
Aug. 12	95	W. Wilson g. x *Burttii*	Sept. 5		+
Aug. 13	96	81 light blue x self.	Sept. 8	+	
Aug. 13	97	8 yellow (wide petals) x *Burttii*	Sept. 3	+	
Aug. 13	98	Persh. x 14	Sept. 3		+
Aug. 14	99	14 yellow x *Burttii*	Sept. 8	+	
Aug. 14	100	7 light blue x self.	Sept. 3	+	
Aug. 14	101	W. Wilson g. x *Burttii*	Sept. 8	+	
Aug. 14	102	W. Wilson g. x *Burttii*	Sept. 5	+	
Aug. 15	103	11 light blue x self	Sept. 8		+
Aug. 15	104	81 dark blue x self	Sept. 9	+	
Aug. 15	105	14 yellow x self	Sept. 5		+
Aug. 17	106	13 dark blue x self	Sept. 8	+	
Aug. 17	107	8 yellow x *Burttii*	Sept. 8	+	
Aug. 17	108	Persh. x 14	Sept. 8		+
Aug. 17	109	W. Wilson g. x 7 light blue	Sept. 3	+	
Aug. 18	110	8 yellow (wide petals) x self	Sept. 3		+
Aug. 18	111	8 light blue x self	Sept. 3		+
Aug. 18	112	14 yellow x self	Sept. 8	+	
Aug. 18	113	2 marm. leaf x self	Sept. 3		+
Aug. 18	114	14 yellow x self	Sept. 3	+	
Aug. 18	115	W. Wilson g. x 7 light blue	Sept. 8	+	

Date of cross	No.	Cross	Date of seed collection	Seed Fertile	Seed Sterile
Aug. 18	116	W. Wilson g. x 7 light blue	Sept. 8	+	
Aug. 18	117	14 yellow x self	Sept. 8		+
Aug. 18	118	11 light blue x self	Sept. 8		+
Aug. 19	119	7 light blue x self	Sept. 12	+	
Aug. 19	120	81 light blue x self	Sept. 12	+	
Aug. 19	121	14 yellow x *Burttii*	Sept. 13	+	
Aug. 19	122	W. Wilson g. x 7 light blue	Sept. 10	+	
Aug. 20	123	13 dark blue x self	Sept. 11	+	
Aug. 20	124	11 light blue x self	Sept. 8		+
Aug. 20	125	8 dark blue x self	Sept. 15	+	
Aug. 20	126	8 yellow (wide petals) x *Burttii*	Sept. 13	+	
Aug. 20	127	14 yellow x self	Sept. 10	+	
Aug. 20	128	W. Wilson g. x 14	Sept. 8	+	
Aug. 20	129	Persh. x 14	Sept. 8	+	
Aug. 21	130	8 light blue x self	Sept. 8		+
Aug. 21	131	14 (copper leaf) x *Burttii*	Sept. 12	+	
Aug. 21	132	13 pink x self	Sept. 14	+	
Aug. 21	133	2 yellow marm. x *Burttii*	Sept. 8	+	
Aug. 21	134	W. Wilson g. x 14	Sept. 8		+
Aug. 22	135	14 yellow x self	Sept. 9	+	
Aug. 22	136	14 yellow x W. Wilson g.	Sept. 12	+	
Aug. 24	137	8 dark blue x self	Sept. 14	+	
Aug. 24	138	*Burttii* x self	Sept. 19	+	
Aug. 24	139	14 yellow (copper leaf) x *Burttii*	Sept. 14	+	
Aug. 24	140	W. Wilson g. x 14	Sept. 15	+	
Aug. 25	141	11 light blue x self	Sept. 12		+
Aug. 25	142	14 yellow (copper leaf) x 14 (green leaf)	Sept. 15	+	
Aug. 25	143	*Burttii* x *Burttii*	Sept. 15	+	
Aug. 25	144	7 light blue x 13 dark blue vivip.	Sept. 18	+	
Aug. 25	145	W. Wil. g. x 13 dark blue vivip.	Sept. 16	+	
Aug. 25	146	W. Wil. g. x *Burttii*	Sept. 16	+	
Aug. 26	147	13 dark blue x 7 light blue	Sept. 16	+	
Aug. 26	148	W. Wil. g. x 7 light blue	Sept. 17	+	
Aug. 27	149	*Burttii* x 81 dark blue vivip.	Sept. 12		+

Date of cross	No.	Cross	Date of seed collection	Seed Fertile	Seed Sterile
Aug. 27	150	W. Wil. g. x 81 light blue vivip.	Sept. 13	+	
Aug. 27	151	W. Wil. g. x 81 light blue vivip.	Sept. 17	+	
Aug. 28	152	*Burttii* x 81 light blue vivip.	Sept. 22	+	
Aug. 28	153	W. Wil. g. x 81 light blue vivip.	Sept. 12	+	
Aug. 29	154	13 dark blue vivip. x *Burttii*	Sept. 18	+	
Aug. 29	155	W. Wil. g. x 13 dark blue vivip.	Sept. 19	+	
Aug. 29	156	W. Wil. g. x 13 dark blue vivip.	Sept. 19	+	
Aug. 29	157	81 dark blue x W. Wil. g.	Sept. 14	+	
Aug. 29	158	*Burttii* x W. Wil. g.	Sept. 24	+	
Aug. 31	159	11 dark blue x self	Sept. 13		+
Sept. 8	160	5 light blue x self	Sept. 24	+	
Sept. 14	161	35 light blue x self	Oct. 12	+	
Sept. 15	162	81 cream fl. x self	Oct. 15	+	
Sept. 16	163	7 light blue x self	Oct. 7		+
Sept. 16	164	11 light blue x self	Oct. 2		+
Sept. 17	165	Whit. g. x Pan. White	Oct. 12	+	
Oct. 3	166	35 x self	Oct. 27		+
Oct. 6	167	Eliot x *Burttii*	Oct. 11	+	
		1932			
Aug. 16	168	14 x 158 yellow Wilson	Sept. 9	+	
Aug. 9	169	162 yellow blue-tipped vivip. x self	Sept. 7	+	
Aug. 16	170	162 yellow blue-tipped vivip. x 158 yellow Wilson	Sept. 11	+	
Aug. 10	171	14 x 107 large yellow	Sept. 10		+
Aug. 9	172	104 violet vivip. x self	Sept. 7	+	
Aug. 9	173	2 x 158 yellow Wilson	Sept. 13		+
Aug. 16	174	104 violet vivip. x 158 yellow Wilson	Sept. 14	+	

Date of cross	No.	Cross	Date of seed collection	Seed Fertile	Seed Sterile
Aug. 10	175	156 type Wilson (more petals) x 104 violet vivip.	Sept. 8	+	
Aug. 10	176	107 dark yellow x 104 pink vivip.	Sept. 8	+	
Aug. 10	177	165 x self	Sept. 3		+
Aug. 9	178	107 good yellow x self	Aug. 29		+
Aug. 10	179	107 dark yellow x 104 pink vivip.	Sept. 1	+	
Aug. 10	180	99 like *Burttii* x self (dark yellow)	Sept. 10		+
Aug. 11	181	162 yellow vivip. x 158 yellow Wilson (like *Burttii*)	Sept. 3	+	
Aug. 11	182	162 white vivip. x self	Sept. 6	+	
Aug. 11	183	104 pink vivip. x 158 yellow Wilson (like *Burttii*)	Sept. 5	+	
Aug. 11	184	158 light yellow Wilson x 104 violet vivip.	Sept. 9	+	
Aug. 11	185	156 vivip. like Wilson x 104 violet vivip.	Sept. 1	+	
Aug. 11	186	107 dark yellow x 107 dark yellow special	Aug. 25		+
Aug. 15	187	156 like Wilson x self	Aug. 15		+
Aug. 15	188	158 like *Burttii* x self	Aug. 29		+
Aug. 15	189	104 violet vivip. x 162 yellow vivip.	Sept. 9	+	
Aug. 15	190	104 pink vivip. x 162 yellow vivip.	Sept. 12	+	
Aug. 15	191	2 x 14 St. Louis	Aug. 29		+
Aug. 15	192	14 St. Louis x 2	Sept. 5	+	
Aug. 15	193	2 x 107 large dark yellow	Aug. 29		+
Aug. 16	194	107 dark yellow x 158 yellow Wilson	Sept. 3	+	
Aug. 17	195	165 white vivip. x self	Sept. 1		+
Aug. 19	196	132 dark pink x 104 pink vivip.	Sept. 6	+	
Aug. 19	197	Missouri x *Burttii*	Sept. 6		+
Aug. 19	198	2 x 162 yellow vivip.	Sept. 9	+	
Aug. 20	199	156 like Wilson x 156 yellow Wilson	Sept. 11	+	

Date of cross	No.	Cross	Date of seed collection	Seed Fertile	Seed Sterile
Aug. 20	200	107 large dark yellow x 156 yellow Wilson	Sept. 13	+	
Aug. 20	201	104 pink vivip. x 156 yellow Wilson	Sept. 13	+	
Aug. 20	202	107 dark yellow x 162 yellow vivip.	Aug. 31		+
Aug. 20	203	14 St. Louis x 162 yellow vivip.	Sept. 13	+	
Aug. 22	204	158 yellow Wilson x self	Aug. 31		+
Aug. 22	205	107 large dark yellow x 99 dark yellow, like *Burttii*	Sept. 14	+	
Aug. 22	206	99 dark yellow like *Burttii* x self	Sept. 28	+	
Aug. 22	207	*Burttii* x 99 like *Burttii*	Sept. 6	+	
Aug. 22	208	14 x 99 like *Burttii*	Sept. 6	+	
Aug. 23	209	Missouri x self	Sept. 21	+	
Aug. 23	210	158 like *Burttii* x 104 pink vivip.	Sept. 6		+
Aug. 23	211	165 x self (blue)	Sept. 5		+
Aug. 23	212	*Burttii* x self	Sept. 12		+
Aug. 23	213	104 pink vivip. x 144 pink vivip.	Sept. 16	+	
Aug. 23	214	162 yellow vivip. (blue tip) x 107 large yellow	Sept. 17	+	
Aug. 25	215	*Burttii* x self	Sept. 15	+	
Aug. 25	216	165 blue x self	Sept. 10		+
Aug. 29	217	light *Burttii* x self	Sept. 24	+	
Aug. 30	218	99 like *Burttii* x self	Sept. 23	+	
Aug. 30	219	162 very light pink x self	Oct. 3	+	
Aug. 30	220	165 blue x self	Sept. 16		+
Aug. 30	221	165 white x self	Sept. 16		+
Aug. 30	222	14 St. Louis x 2	Sept. 24	+	
Aug. 30	223	2 x 14 St. Louis	Sept. 13		+
Aug. 31	224	158 like *Burttii* x self	Sept. 1		+
Aug. 31	225	156 like Wilson x self	Sept. 19		+
Aug. 31	226	96 salmon-pink x self	Sept. 24	+	
Sept. 1	227	Pink Pearl x 162 yellow vivip. (blue tips)	Oct. 3	+	
Sept. 1	228	Edw. C. Eliot x 162 yellow vivip. (blue tips)	Sept. 23	+	

Date of cross	No.	Cross	Date of seed collection	Seed Fertile	Seed Sterile
Sept. 1	229	Pan. white x *caerulea*	Oct. 3	+	
Sept. 2	230	89 yellow cup-shape x self	Oct. 1		+
Sept. 2	231	122 good blue x self	Oct. 26	+	
Sept. 2	232	Missouri x 162 yellow vivip.	Sept. 19		+
Sept. 2	233	St. Louis 14 x 107 large yellow (dark)	Sept. 24		+
Sept. 3	234	106 good blue like Shaw x self	Oct. 17	+	
Sept. 3	235	144 salmon-pink vivip. x self	Oct. 10	+	
Sept. 7	236	152 Indep. yellow x 123 dark red	Oct. 8	+	
Sept. 7	237	135 dark yellow x 123 dark red	Oct. 7	+	
Sept. 8	238	101 cream-colored x self	Oct. 3		+
Sept. 8	239	158 like *Burttii* x self	Sept. 29		+
Sept. 8	240	96 light blue vivip. x self	Oct. 7	+	
Sept. 13	241	123 red x 152 good yellow (blue tips)	Oct. 10	+	
Sept. 14	242	160 good yellow Shaw x self	Oct. 11		+
Sept. 14	243	107 large yellow x Missouri	Oct. 10		+
Sept. 15	244	100 good light pink Koch x self	Nov. 2	+	
Sept. 17	245	87 yellow like *Burttii* x self	Nov. 2	+	
Sept. 17	246	*Burttii* x *Burttii*	Nov. 8	+	

1933

Aug. 17	247	147 white vivip. (pink stamens) x self	Sept. 5		+
Aug. 17	248	123 red x self	Sept. 20	+	
Aug. 19	249	147 white vivip. (pink stamens) x self	Sept. 5		+

Date of cross	No.	Cross	Date of seed collection	Seed Fertile	Seed Sterile
Aug. 19	250	151 best Wilson vivip. x self	Sept. 6		+
Aug. 21	251	96 cream vivip. (green leaf) x self	Sept. 8		+
Aug. 21	252	151 best Wilson vivip. x self	Sept. 6		+
Aug. 22	253	104 pink vivip. x self	Sept. 18	+	
Aug. 23	254	123 red x 138 dark yellow	Sept. 12		+
Aug. 23	255	147 white vivip. (pink stamens) x 96 rose-pink	Sept. 20	+	
Aug. 23	256	96 rose-pink x self	Sept. 23	+	
Aug. 24	257	151 best Wilson vivip. x self	Sept. 6		+
Aug. 24	258	123 red x 138 dark yellow	Sept. 18	+	
Aug. 25	259	138 dark yellow x self	Sept. 14	+	
Aug. 25	260	151 best Wilson vivip. x 138 dark yellow	Sept. 11	+	
Aug. 26	261	104 pink vivip. x self	Sept. 18	+	
Aug. 26	262	151 best Wilson vivip. x 104 pink	Sept. 16	+	
Aug. 26	263	96 white vivip. (green leaf) x self	Sept. 18		+
Aug. 28	264	151 best Wilson vivip. x self	Sept. 11		+
Aug. 28	265	147 white vivip. (pink stamens) x self	Sept. 18	+	
Aug. 29	266	151 best Wilson vivip. x self	Sept. 14		+
Aug. 30	267	96 rose-pink x self	Sept. 26	+	
Aug. 30	268	123 red x self	Sept. 14		+
Aug. 30	269	123 red x 138 dark yellow	Sept. 20		+
Aug. 31	270	138 dark yellow x self	Sept. 18	+	
Aug. 31	271	104 pink vivip. x self	Sept. 25	+	
Sept. 6	272	147 white vivip. (pink stamens) x self	Sept. 29	+	
Sept. 6	273	123 red x self	Sept. 27	+	
Sept. 7	274	246 *Burttii* x self	Oct. 2	+	
Sept. 7	275	151 best Wilson vivip. x self	Sept. 22		+

Date of cross	No.	Cross	Date of seed collection	Seed Fertile	Seed Sterile
Sept. 8	276	138 dark yellow x self	Sept. 28	+	
Sept. 8	277	246 *Burttii* x self	Oct. 6	+	
Sept. 8	278	147 white vivip. (pink stamens) x self	Oct. 2	+	
Sept. 13	279	138 dark yellow x 123 red	Oct. 9	+	
Sept. 13	280	96 rose-pink x 138 dark yellow	Oct. 23	+	
Sept. 15	281	246 *Burttii* x self	Oct. 8		+
Sept. 15	282	151 best Wilson vivip. x 246 *Burttii*	Oct. 23	+	
Sept. 15	283	96 white vivip. (green leaf) x 246 *Burttii*	Oct. 23	+	

G. H. P.

THE AMAZON WATER-LILY (VICTORIA CRUZIANA)

This giant water-lily, commonly called water-platter or Amazon water-lily, has circular leaves with upturned edges measuring up to five feet in diameter. Although thin, the leaves are well strengthened by a framework of veins and are capable of sustaining weight up to 160 pounds or more. (See BULLETIN, Vol. 15, No. 8, p. 125, "Amazon water-lilies as engineers.") In order to equalize the weight of a person standing on such a leaf and prevent the leaf being torn, it is necessary to cover it with first a cotton pad and then a frame of wood or composition board.

The flowers are nocturnal, measuring twelve to fourteen inches in diameter, white the first night of opening, later turning pink. The older flowers have a fragrance strongly resembling that of pineapple. The exterior of the flowers, flower stems, leaves, and leaf stems are armed with dagger-like spines.

A plant sometimes has eight to ten leaves at one time, growing from its center. To accommodate a water-lily of

this size the pool should be at least twenty feet in diameter. In a natural pool it will have sufficient room for root development, but in a constructed pool a cubic yard of soil should be allowed for each plant. However, the amateur gardener need not be dissuaded by these measurements as the size of the plant may be governed by the amount of soil given the roots, and a small specimen may be grown in an ordinary half barrel.

Culture.—Since the season for growing the plants outdoors is only four months, it is seldom that the seed-pods ripen in the pool. They should be left attached to the plant until the first light freeze, when they should be collected and placed in a tub of water in the greenhouse. It is suggested that leather gloves or forceps be used when cutting the pods, for they are more spiny than cacti. Before the water becomes black and putrid it should be changed. Within six weeks the seeds will be free from the pod and show a light yellow color, and should be separated from the pulp and dagger-like spines by screening. Again, care must be used in handling the spines, for they are more annoying at this stage than when attached to the pod. Formerly, the seeds were allowed to remain in the water for twelve to eighteen months until the ripening process was completed, but recent experiments at the Garden have shown that the seeds ripen more quickly when packed in a tin box between layers of fine moist sand and kept at a temperature of 60° F. Germination is also hastened when seeds are ripened by this method. The top of the box should be kept securely fastened, since rats and mice are extremely fond of these farinaceous seeds and have even been known to remove them from buckets filled with water. It is essential that the seeds be fully ripe before being planted, those two years old showing a better percentage of germination than young seeds. Seeds have been known to germinate in the pond outside (despite it being drained in the winter) three years after the plant had been growing in the pool.

When fully ripe the seeds are about the size of an ordinary garden pea and are dark brown to black in color. They should be planted in shallow pans about March 1, about

twice their depth, in a medium of half sand and half soil screened through a ¼-inch sieve. The pans should then be submerged in a tank of water filled to three inches above the tops of the pans and heated to 80° F. Within three to four weeks germination is evidenced by a needle-like shoot appearing from the soil. A long lance-shaped submerged leaf and an ovate floating leaf are the next stages. When two oval floating leaves have developed, the seedlings should be separated and planted in 3-inch pots, using three-fourths sod soil and one-fourth sand. To prevent the soil washing out a piece of broken flower-pot or a layer of moss should be put in the bottom of the pot, and a ¼-inch layer of sand sprinkled on top of the soil after potting. As a fertilizer inorganic manure, with an analysis of 15 nitrogen, 30 soluble acid phosphate, and 15 soluble potash, has produced better results at the Garden than cow manure. In addition to the inorganic fertilizer being more easily obtainable its use has resulted in more rapid growth of plants, more luxuriant foliage and flowers, and an earlier ripening of seed-pods. When the pot becomes filled with roots the plant should be transplanted into an 8-inch pan, which is large enough to carry it through until planted outside.

The time of planting naturally depends upon the weather, but it should not be done until the temperature of the water is about 75-80° F. This is usually between June 1 and June 15 in St. Louis, but naturally earlier in the southern states, and later further north. Plenty of root room and free use of manure is essential to bring this plant to giant proportions in eight weeks, its period for maturing. When planted in natural ponds, as at the Garden, an area of one hundred square feet should be outlined and covered with two inches of cow manure, or one ounce per cubic foot of the inorganic manure, either of which should be spaded under at least one foot in depth and mounded up slightly at the center to indicate place of planting. When first planted outside the leaves are generally about one foot in diameter. As their stems develop they should be pegged to prevent the leaves tearing and upturning during wind-storms. G. H. P.

NOTES

Dr. William Randolph Taylor, Professor of Botany, University of Michigan, spent the day at the Garden, March 16.

Dr. Carroll W. Dodge, Mycologist to the Garden, gave an illustrated lecture on "Lichens" to the Webster Groves Nature Study Society, March 12.

Mr. B. Y. Morrison, Senior Horticulturist, Bureau of Plant Industry, and Secretary of the American Iris Society, visited the Garden, February 27.

Mr. John H. Kellogg, Plant Collector to the Missouri Botanical Garden, gave a radio talk for the Community Council over Station KWK, March 27, on "Missouri Trees."

Dr. George T. Moore, Director of the Garden, spoke before the Men's Club of the Church of St. Michael and St. George, March 7, on "A Respect for Plants."

The article on "Carrion Flowers" in the November, 1933, number of the BULLETIN, by Mr. Ladislaus Cutak, in charge of Succulents at the Garden, has been reprinted in the "Garden Digest" for March.

The "Revista Sudamericana de Botanica," Vol. 1, No. 1, contains an article by Dr. C. W. Dodge, Mycologist to the Garden, entitled "Contribucion al Conocimiento de la Evolucion de los Gasteromicetos."

Mr. George H. Pring, Superintendent of the Garden, spoke before the science section of the Wednesday Club, February 28, on "Breeding Tropical Water-Lilies," and before the Monday Circle, March 5, on "Plant Exploration."

Mr. L. P. Jensen, Manager Missouri Botanical Garden Arboretum, has given the following talks recently: before the Parent-Teachers Association of the Sappington School, Sappington, Mo., March 2, on "Planning and Planting the Home Grounds"; before the Garden Club of Gray Summit, March 5, on "Pruning of Ornamental Trees and Shrubs"; before the Parent-Teachers Association of the Union School, Union, Mo., on "Gardening as a Hobby."

STATISTICAL INFORMATION FOR FEBRUARY, 1934

GARDEN ATTENDANCE:

Total number of visitors.....22,981

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought..... 51
Total number of books and pamphlets donated..... 72

PLANT ACCESSIONS:

Total number of seed packets donated..... 140

HERBARIUM ACCESSIONS:

By Purchase—

Mexia, Mrs. Ynes—Plants of South America and Mexico 854
Royal Botanic Gardens, Kew, England — Photograph of type specimen..... 1
Schimpff, H. J. F.—Plants of the Galapagos Islands.... 145
Weigel, Th. Oswald—Weese, "Eumycetes selecti exsiccati," Fasc. 25-26, Nos. 601-650, inclusive..... 50

By Gift—

Cufodontis, Dr. G.—*Senecio phanerandrus* Cuf. from Costa Rica 1
Kellogg, John H.—Plants of Missouri collected by B. F. Bush 17
Lodewyks, Maude C.—Plants of Missouri..... 53
Osterhout, George—*Mertensia myosotifolia* Heller from Colorado 1
Steyermark, Julian A.—Specimen of moss from Missouri 1
Williams, Louis O.—Plants of Colorado and Utah..... 6
Woodson, R. E., Jr.—Apocynaceae and Asclepiadaceae of Central America collected by C. L. Lundell..... 70

By Exchange—

U. S. National Museum—Malvaceae from Texas, Arizona and California 8

By Transfer—

Cutak, Ladislaus—*Kalanchoe* sp. of horticulture..... 1

Total 1,208

SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date to the death of Mr. Shaw, in 1889, the Garden was maintained under the personal direction of its founder, and, while virtually a private garden, it was, except at certain stated times, always open to the public. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was designated by Mr. Shaw as its official title and in his will or in any of his writings he specifically referred to it as the "Missouri Botanical Garden." By a provision of Mr. Shaw's will the Garden passed at his death into the hands of a Board of Trustees. The original members of the Board were designated in the will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will, the immediate direction of the Garden is vested in a Director, appointed by the Board of Trustees. The Garden receives no income from city or state, but is supported entirely from funds left by the founder.

The city Garden comprises 75 acres, where about 12,000 species of plants are growing. There is now in process of development a tract of land of over 1,500 acres outside the city limits which is to be devoted to (1) the propagation and growing of plants, trees, and shrubs, designed for showing either indoors or outside, at the city Garden, thus avoiding the existing difficulties of growing plants in the city atmosphere; (2) gradually establishing an arboretum as well as holding a certain area as a forest reservation, with the idea that possibly at some future time this may become the new botanical garden.

The Garden is open to the public every day in the year, except New Year's Day and Christmas—week days from 8:00 a. m. until one-half hour after sunset; Sundays from 10 a. m. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Place, on the Sarah car line (No. 42). Transfer south from all intersecting lines. The Garden may also be reached by Bus Route No. 99, to which all other motor-bus lines transfer.

STAFF
OF THE MISSOURI BOTANICAL GARDEN

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Missouri Botanical Garden Bulletin

Vol. XXII APRIL, 1934 No. 4

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1
CROSS-SECTION OF PINE TRUNK, SHOWING DECREASE IN ANNUAL GROWTH, RESULTING IN DEATH

2
GROWTH OF BLACK WALNUT DURING TWO DRY SEASONS

Missouri Botanical Garden Bulletin

Vol. XXII APRIL, 1934 No. 4

HOW TO FEED A SHADE TREE

Most of us are deeply affected by the death of a favorite tree, especially if we know its history and have watched its struggles. In addition to the sentimental feeling, trees contribute immeasureably to the beauty of a town or city and add to the life of its citizens. We are even told that they assist in the prevention of crime; and certainly they affect real-estate values. Therefore, the care and preservation of many an old tree seem justified, no matter how expensive or difficult.

In the October, 1929, number of the BULLETIN, an article on "The Feeding of Shade and Ornamental Trees" attempted to bring together such information as was then available on the subject. It was pointed out that there was no satisfactory agreement as to either the formula or the amount of fertilizer to be used and consequently experiments were under way at the Garden in the hope that eventually a more definite and satisfactory method of feeding trees might be arrived at. The following account gives the result of these experiments to date.

Starvation is the most common cause of death in mature shade trees. This can be clearly seen if the conditions under which they grow are compared with those found in the forest. In lawns and parks the leaves are removed and burned; perhaps once a year the lawn is rolled, while all year countless

feet compact the soil. Thus it becomes impossible for rain or snow to penetrate deeply. In the woodland, leaves are left to blanket the soil, keeping it loose and retentive of moisture. Decomposition converts the leaves into mold which eventually serves as food for the tree. Rain and snow slowly percolate through this cover, carrying along plant food.[1] Shade and forest tree have the same requirements, but Nature has supplied the forest tree with food and a method of conserving soil moisture. To overcome the effects of city life and to avert starvation, abundant food must be supplied to the tree.

The first symptom of starvation is a decrease in the terminal growth. In most shade trees, except the dwarf varieties, a terminal growth of four inches a year should be considered the minimum, six or eight inches normal, while a terminal growth of twelve inches or more indicates a tree not in need of food. Below the minimum growth of four inches starvation symptoms become very marked. Coincident with the diminished growth there is a rapid decrease in the size of the leaf combined with a loss of green color, in serious cases only the venation remaining green. While a careful diagnosis is particularly important, shade trees generally are so dangerously under-fed that it is better to feed first and diagnose later. An under-fed tree cannot resist borer attacks; neither can it withstand dry weather; nor can it sacrifice any more of its few leaves during a caterpillar invasion. A well-fed tree will require much less water than its starving neighbors. Shade trees cannot be over-fed.

The death of an Austrian pine at the Garden in 1932 furnished an unusual opportunity to study the effect of starvation on the growth rate. By means of a post-mortem examination, in which the whole tree was sectioned longitudinally, the exact increase in height (fig. 1) and diameter (pl. 33, fig. 1) for each year was determined. Starvation caused a remarkable stunting, particularly in height. During the first nineteen years of its life it grew 31 feet, 8 inches, which

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[1] The term "food" is here used in its popular sense. Every green plant manufactures its own food from elements supplied through the air and soil. It is the lack of these elements which causes starvation.

was 83 per cent of its mature height. The remaining thirty-eight years contributed only a meagre 6 feet, 5 inches. The same ratio existed between the early and late diameter increase. This pine, planted in 1873, was almost as large in

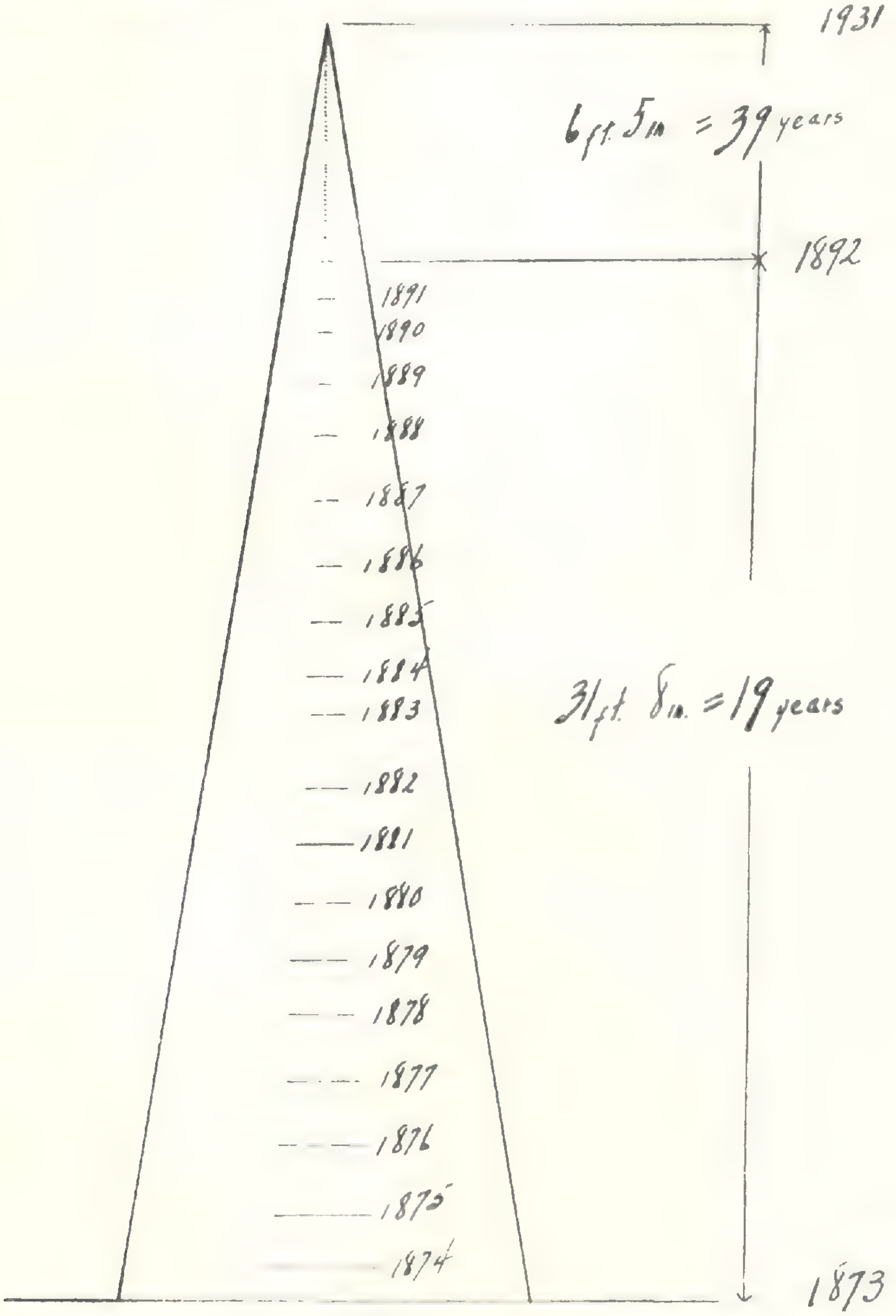


Fig. 1. Annual height increase of *Pinus austriaca*.

1892 as it was thirty-eight years later. The effect of a diminishing food supply is clearly evident in this case. Along with other conifers, the pine has the added disadvantage of suffering from atmospheric pollution, which would be reflected in a diminished growth rate. Indirectly all trees are injured by smoke and its accompanying noxious gases, some of which form an insoluble compound when coming in contact with the soil lime. This causes a deficiency of lime, which produces a change in the soil structure and inhibits the growth of the flora of the soil, leaving what little plant food was present in an unavailable form.

Experimental work extending over five years has shown that the shortage of three elements only will limit shade tree growth. These three are: nitrogen, phosphorus, and potash. Since a chemical analysis fails to show the satisfactorily available plant food in the soil, it is necessary to try out these elements singly and in combination. No other method will demonstrate their importance and proportion in a balanced tree food. For two years a double row of eighteen ash and twenty-five black walnut trees was used for testing. The changes which the various elements, singly and in combination, made in the condition and growth rate were checked against the previous growth rate. Such a comparison eliminates the use of check trees, and furthermore is more satisfactory since it is impossible to find two trees alike. During these tests the most outstanding results were obtained with nitrogen, and second in importance was phosphorus. The third element, potash, showed no startling results when used alone, but it quickly became a limiting factor when absent from a combination of nitrogen and phosphorus. Continued work showed that for shade trees in this region a complete tree food should contain 10 per cent nitrogen, 8 per cent phosphorus, and 6 per cent potash. A typical record of a small ginkgo, No. 7A, shows the evolution of the present fertilizer formula:

1929	5	pounds	4-8-4
1930	10	pounds	8-6-4
1931	12	pounds	8-8-4
1932	25	pounds	8-8-4
1933	25	pounds	10-8-6

This tree belonged to the group fed the amount and kind of food which had proved most effective for the experimental trees during the previous year. The most noticeable feature of this record is the five-fold increase in dosage and the more than doubling of the nitrogen content. This means that all trees were being fed over ten times as much nitrogen in 1933 as in 1929. This same change in formula and dosage has occurred in each tree of the group of sixty-seven of which Ginkgo No. 7A was a member. In all cases the growth rate has shown a very close relationship to the amount of food given and especially to the percentage of nitrogen it contained. Thus:

RECORD OF QUERCUS PALUSTRIS No. 4

Fertilizer	Amount (pounds)	Date applied	Trunk Diameter (inches)	Increase (inches)
8–4–6	3	6/7/28	.60	.00
4–8–4	4	5/24/29	.70	.10
4–8–4	5	6/19/30	1.15	.45
8–8–4	10	6/7/31	2.20	1.05
8–8–4	25	6/3/32	3.40	1.20
10–8–6	25	5/29/33	4.70	1.35

This typical record indicates the need for large quantities of food, nearly half of which should be nitrogen.

The three materials required for shade tree food may be purchased separately and mixed, or they may be obtained mixed and ready for use. In purchasing fertilizers it is necessary that the analysis be known. This is usually printed on the sack, and is expressed as "per cent available". In no other way can the potential value of a fertilizer as a shade-tree food be judged. Shade trees always need a quickly available food. A fertilizer which becomes slowly available and has an analysis much below the suggested 10 per cent nitrogen, 8 per cent phosphorus, and 6 per cent potash is of little value to them. It is equally important that the material from which it is made be known, since this affects

its solubility and therefore its value. The cost per bag is a poor criterion in selecting fertilizers. Nitrogen may be obtained either as ammonium sulphate or as nitrate of soda. Both have the same analysis, testing about "20 per cent available nitrogen". Phosphorus is supplied as super-phosphate, analyzing "20 per cent available phosphoric acid". Potash is commonly furnished as muriate of potash, generally "50 per cent available potash". The above four materials are not the only sources of plant food suitable for mixing as complete fertilizers, but they are the most easily obtained.

To make 200 pounds of a 10-8-6 tree food, the indicated amounts of each of the following are needed:

Ammonium sulphate or Nitrate of Soda	if analyzing "20% available"	use	100 pounds
Super-phosphate	if analyzing "21% available"	use	76 pounds
Muriate of potash	if analyzing "50% available"	use	24 pounds
			200 pounds

To calculate the amount of fertilizer necessary, should any material analyze a different "per cent available" instead of that used above, the following table should be used:

Analyses as printed on bag. (Read down)	Number of pounds of commercial nitrogen, phosphorus and potash needed to make 200 pounds of complete tree food. (Read across)					
	5%	6%	7%	8%	9%	10%
10%	100	120	140	160	180	200
11%	91	109	127	146	164	182
12%	83	99	116	133	150	166
13%	77	93	107	123	139	154
14%	71	85	99	114	128	142
15%	67	80	93	107	120	134
16%	63	75	88	100	113	126
17%	59	70	82	94	106	118
18%	56	67	77	88	99	111
19%	53	63	74	85	95	106
20%	50	60	70	80	90	100
21%	48	57	67	76	86	96
22%	46	54	64	73	82	92
23%	44	52	61	70	79	88
24%	42	50	58	67	75	84
25%	40	48	56	64	72	80
26%	39	46	54	62	70	78
27%	36	43	50	57	67	74
28%	36	43	50	57	64	72
29%	35	41	48	55	62	70
30%	33	39	46	53	59	66
31%	32	38	44	50	57	64
32%	31	37	43	49	56	62
33%	30	36	42	48	54	60
34%	29	34	40	46	52	58
35%	28	33	39	45	50	56
36%	27	32	38	44	49	54
37%	26	31	37	43	48	53
38%	25	30	36	42	47	52
39%	25	30	35	41	46	51
40%	24	29	34	40	45	50
41%	23	28	33	39	44	49
42%	23	27	32	38	43	48
43%	23	27	32	36	40	46
44%	22	26	31	35	39	45
45%	22	26	31	34	38	44
46%	21	25	29	33	37	43
47%	21	25	29	32	36	42
48%	21	24	28	32	36	42
49%	20	24	28	32	36	40
50%	20	24	28	32	36	40

Example: If the source of nitrogen analyzes "25 per cent available" read down the first vertical column to 25 per cent and across to the 10 per cent column, where will be found the figure 80, which is the number of pounds of nitrogen needed for 200 pounds of a 10 per cent tree food. The same table and the same method are used to calculate the amount of phosphorus and potash. If a highly concentrated material is used to compound a complete tree food, the weight and bulk may be so much reduced that an inert filler must be used to bring the weight to two hundred pounds. Thus, if a fertilizer analyzing "46 per cent available nitrogen" is used, only 43 pounds will be needed for 200 pounds of a ten per cent formula. The difference can be made up by using fine sand as a filler, or by using 7/10 of a pound in place of a pound.

Due to a lack of experimental evidence, the correct amount of food needed for a large tree has been variously estimated from one pound per foot height, to certain amounts per inch diameter. No previously published table has taken into consideration the type of tree, whether spire-like or spreading. Since no one measurement can be depended upon to furnish an accurate estimate of the volume of a tree many efforts to feed trees have been unsuccessful. To determine a formula for measuring volume upon which to base dosage, 273 trees growing in various situations were carefully measured. A transit was used to determine the height, and a steel tape was used to measure the spread of the branches and the trunk circumference. These measurements showed clearly that if dosage is to be based upon volume, the height, spread, and circumference of the tree must be known.

The correct way to calculate the amount of food needed (fig. 2) is as follows: To the height (in feet), add the diameter of branch spread (in feet), and to this add the trunk circumference (in inches). The resulting figure is the number of pounds of 10-8-6 fertilizer needed. For instance, a tree 35 feet high, having a branch spread of 30 feet and a trunk circumference of 38 inches, would require 103 pounds of 10-8-6 fertilizer. Should the tree have a high crown (fig. 3), as is common among street, lawn, or open forest trees, then use only ⅔ of the calculated dosage. Should the crown be very high, such as is found in trees in

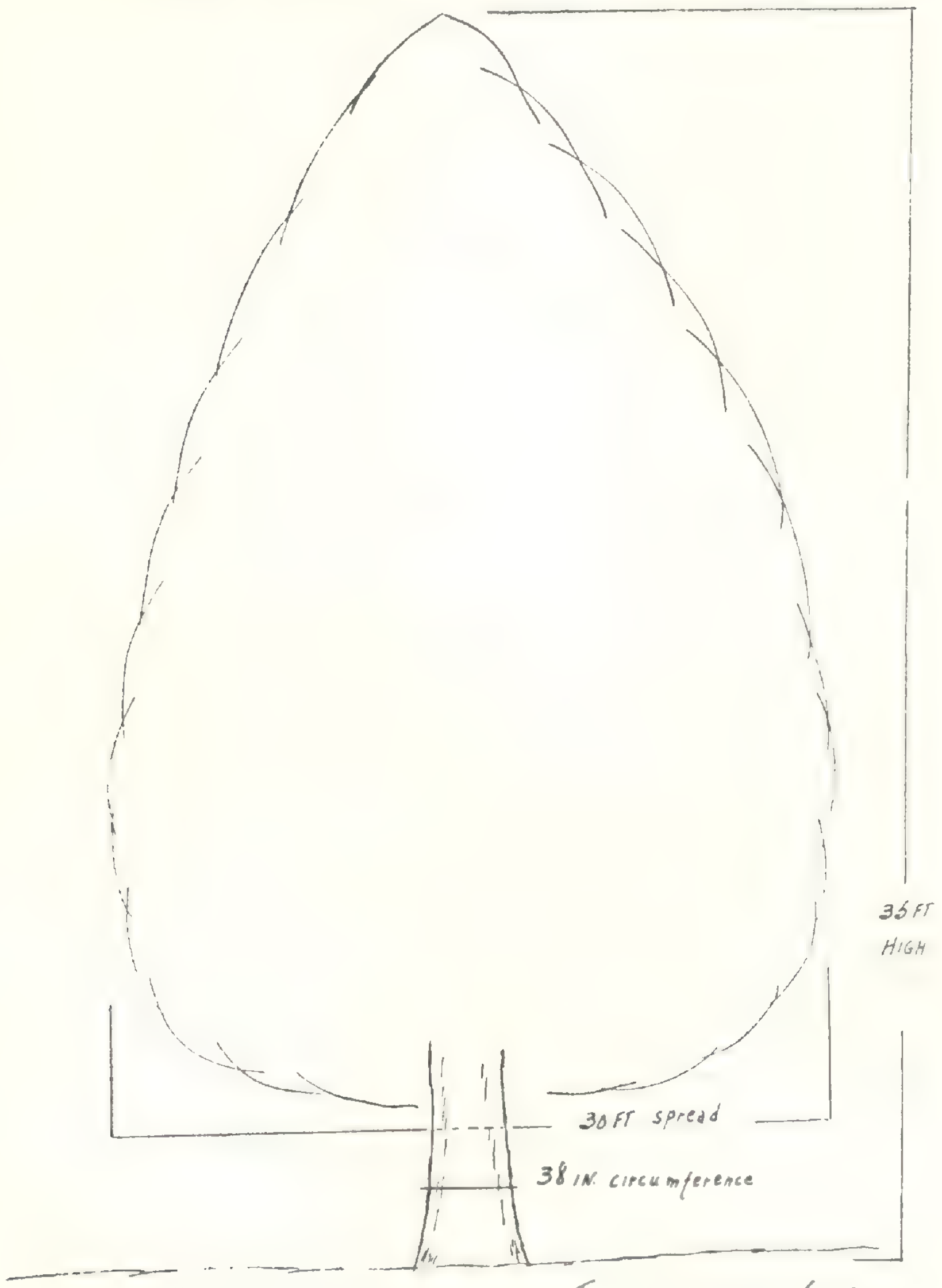

35 FT
HIGH
30 FT spread
38 IN. circumference
How fertilizer dosage is calculated: To the height in feet (35 ft) add
The branch spread in feet (30) and the Trunk circumference in inches (38) —
The sum 103 lbs is the amount of 10-8-6 fertilizer needed

Fig. 2.

the dense forest, then use ½ of calculated dosage. By using this method to calculate dosage, from three to five times more food will be given to each tree than has heretofore been thought needed. It has been supposed that such large amounts placed about the roots during a dry season

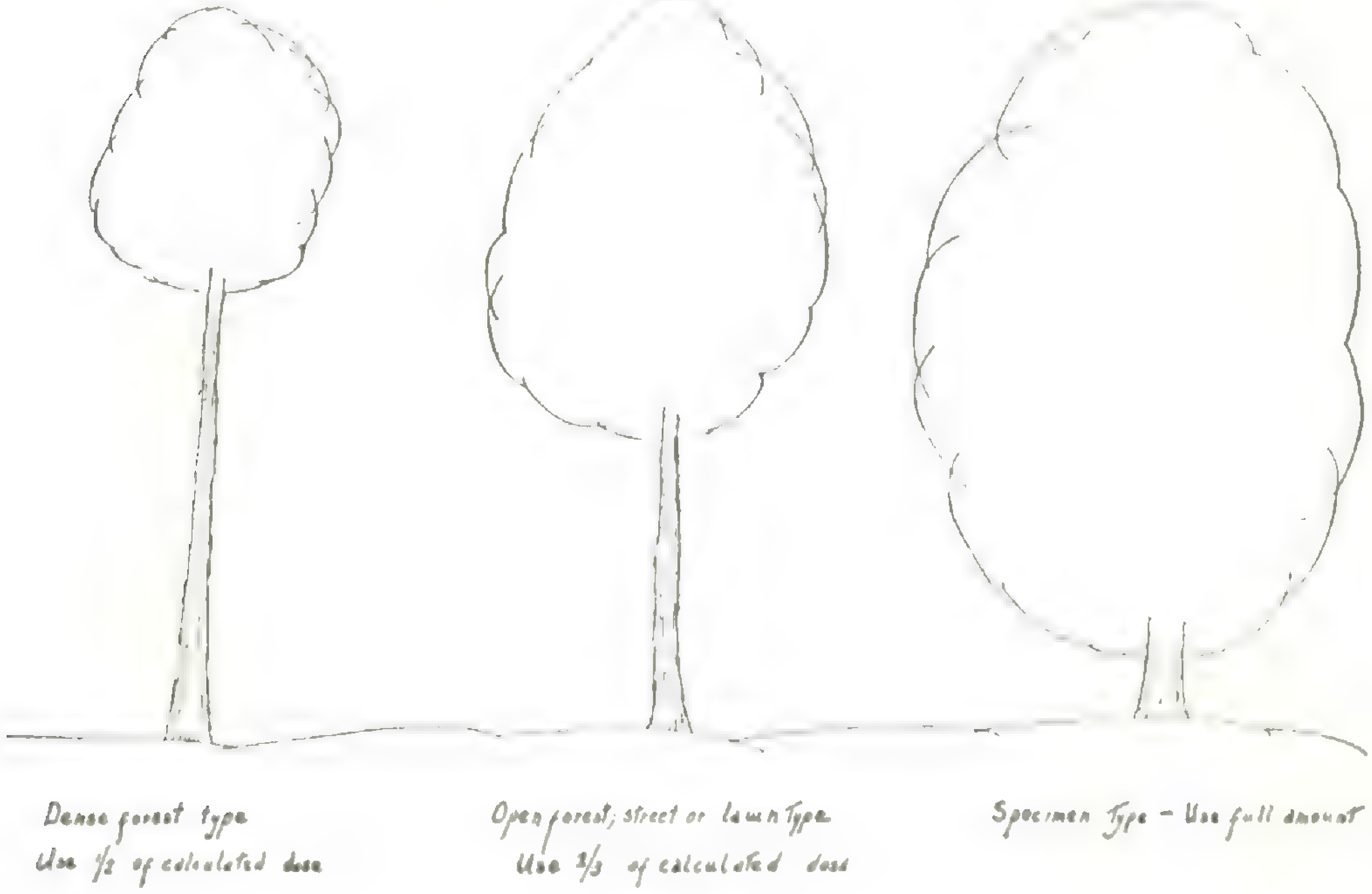
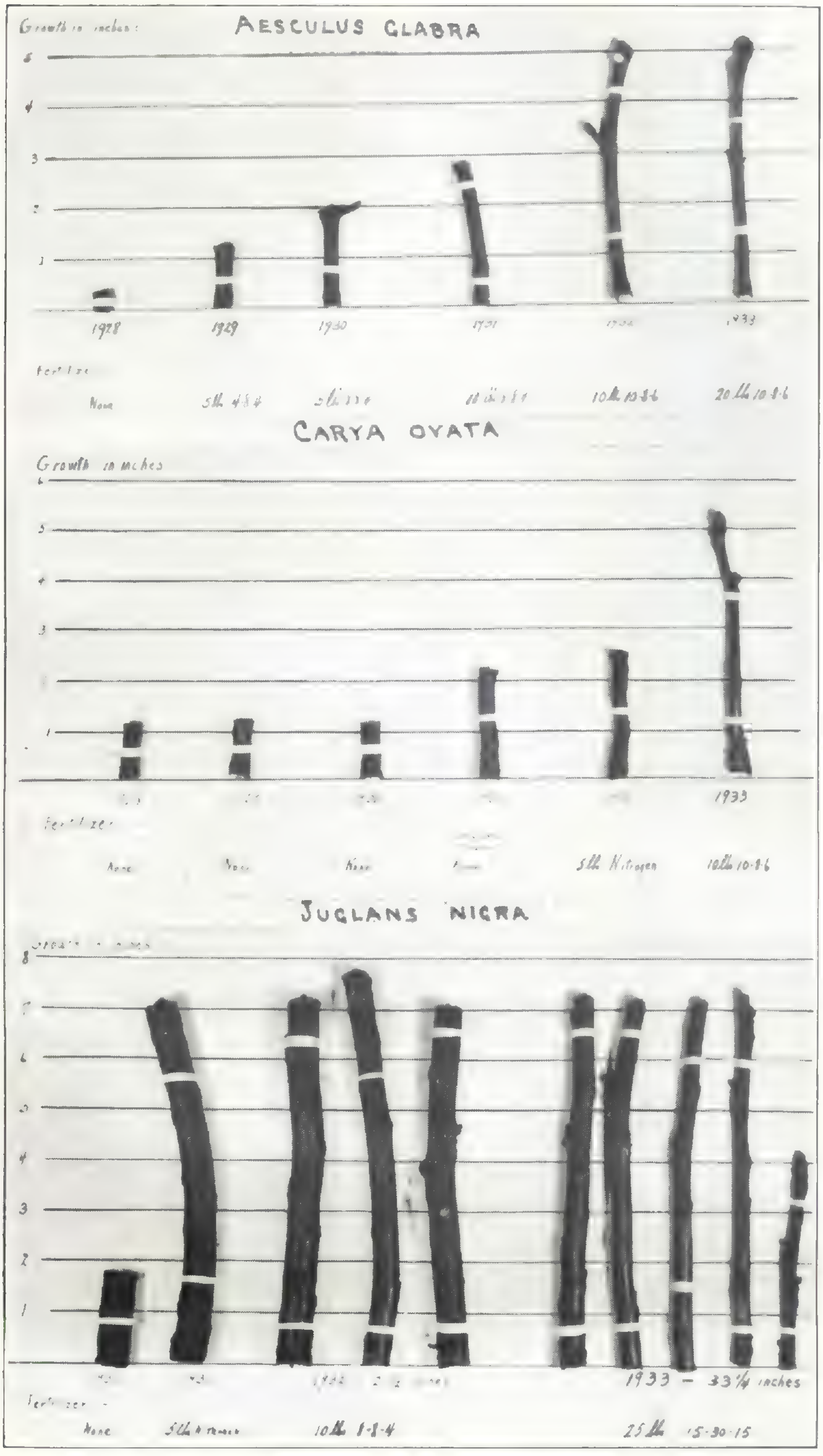


Fig. 3.

would result in death. This has never occurred, and so far no tree in the Garden has even been "burned", although, based on previous dosage tables, all have been over-fed. The largest buckeye (Aesculus) has received the equivalent of 280 pounds of a 10-8-6 fertilizer. Several small black walnuts (1¼ inches in diameter) were given 25 pounds of a 15-30-15 fertilizer. This they very enthusiastically welcomed (pl. 33, fig. 2), making an average twig growth of 42 inches during the dry summer of 1933. On an English walnut, which had also been "over-fed," a shoot growing from the crown measured 11 feet, 4 inches; the total length of new growth on this tree for 1933 measured 69 feet. The effect of feeding trees which had for years been making a meagre growth is shown (pl. 34, fig. 1) by the buckeye



BRANCHES OF TREES SHOWING ANNUAL GROWTH OF UNDER-FED TREES, AND EFFECT OF FERTILIZER. TOP—BUCKEYE (AESCULUS GLABRA); CENTER—HICKORY (CARYA OVATA); BOTTOM—BLACK WALNUT (JUGLANS NIGRA)

1
POST-HOLE METHOD, LEAF-MOLD, PEAT OR MANURE PLUS FERTILIZER USED TO FILL HOLE

2
HOLE 16–18 INCHES DEEP, MADE WITH PUNCH-BAR

(*Aesculus glabra*) which grew less than ½ inch in 1928. Fertilizing was started the following year with five pounds of 4-8-4 fertilizer. This was gradually increased each year. The first nearly normal growth made by this tree for many years occurred in 1932 when it grew five inches. A hickory (*Carya ovata*) (pl. 34, fig. 2) had attained a height of seven feet and trunk diameter of 2½ inches in twenty-eight years. It was very near death from starvation, as was shown by its response to feeding. The black walnut (*Juglans nigra*) (pl. 34, fig. 3) was fifteen years old and three feet high in 1930, when the first efforts to feed it were started. The use of five pounds of nitrate of soda in 1931 caused it to grow seven inches in height that year. In the two years following it was included in a group of trees which were to be fed "toxic" doses of fertilizer. So far all of these trees have eagerly accepted all food which has been given to them. The above walnut grew 21½ inches in 1932, and 33¼ inches in 1933, both very dry years.

Five methods of applying food have been in use: (1) trenching, (2) post-hole, (3) punch-bar, (4) broadcast and spading, (5) injection, using either water or air pressure. The trench method was used with an organic manure, and was satisfactory if the tree in question were not in serious danger. An adaptation of this method was the post-hole digger (pl. 35, fig. 1), which made holes at irregular intervals and permitted the use of both organic and commercial fertilizers. Both of the above methods leave a lawn unsightly. The punch-bar (pl. 35, fig. 2, pl. 36) was used only with commercial fertilizers. It has proved entirely satisfactory, but becomes exceedingly laborious in hard, dry soil. The broadcasting of fertilizer on the soil and spading it under has much to recommend it. Spading if done properly, has proved beneficial, and the turning under of a four-inch layer of stable manure re-enforced with commercial fertilizer is a very effective method of feeding large low-branched trees. The bed thus formed can extend to the branch tips and may be reserved for shade-tolerant plants. Fertilizer when injected underground in solution or forced under in a dry state is most quickly available to the tree. It is much more effective than placing food in holes to await a rain. A

watering needle which has been in use in the Garden for several years, has shown itself of considerable value in making holes (pl. 37, fig. 1). This is a simple device consisting of a soil rod 40 inches long made of ¼-inch galvanized pipe. The top is fitted with a "T" which serves as a handle and inlet. One side is capped, and the other fitted with a stop-cock to which a heavy garden hose is attached. The tip of the needle is placed in contact with the ground, and the water slowly turned on. The needle with the water running

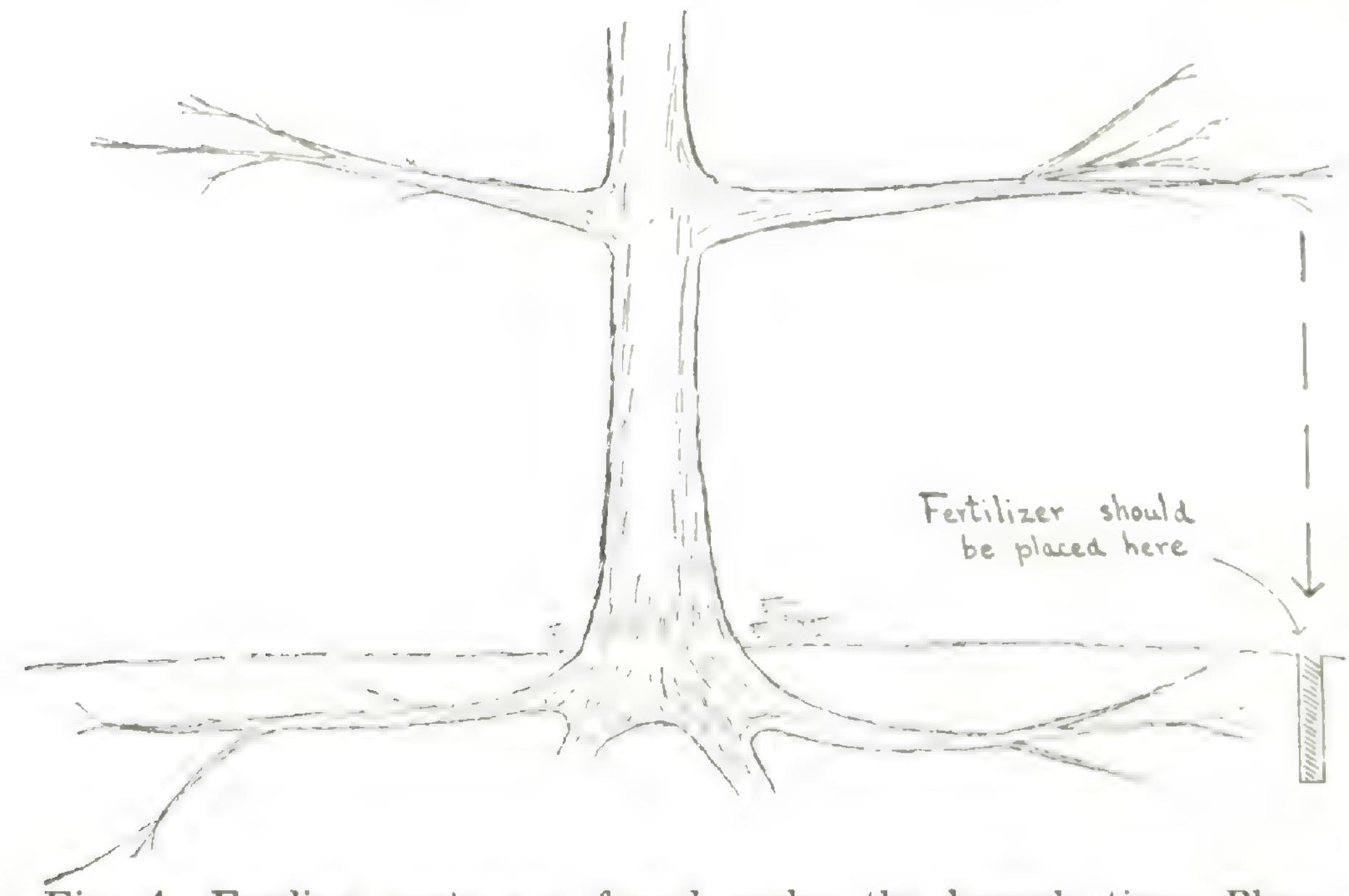


Fig. 4. Feeding roots are found under the branch tips. Place fertilizer in holes under branch tips.

can be very easily forced under ground to any required depth. After the needle is withdrawn, tree food may be watered in the hole thus made. More effective feeding can be done with a high-pressure spraying outfit. The fertilizer should be dissolved in a tank, and the solution then pumped underground. The objection to this method lies in the corrosive action of the fertilizers when in contact with a metal surface. A pressure feeding gun (pl. 37, fig. 2) recently developed at the Garden combines the advantages of the

1

PLACING TROWEL OF FOOD IN PUNCH-BAR HOLE

2

MAKING HOLES AROUND TREE BY PUNCH-BAR METHOD

1

WATERING NEEDLE USED TO MAKE HOLES FOR FEEDING

2

MEASURING FERTILIZER AND CHANGING CYLINDER OF PRESSURE GUN

watering needle and the power sprayer. It has the long soil rod of the needle, by which food may be injected to any required depth, but also it permits the use of dry material. The use of fertilizer with this equipment has resulted in the renewed growth of shrubs five days after application.

To be effective fertilizer should be placed near the feeding roots, which are commonly found at the tips of the large roots. For fertilizing purposes the root spread may be considered no greater than the branch spread, and the fertilizer should therefore be placed (fig. 4) under the branch tips. Feeding should be done annually until the growth rate has become normal for that tree. It may then be discontinued until the growth rate again decreases and the tree shows signs of needing food. For large trees, it is better to feed smaller amounts annually than to discontinue feeding altogether. Efforts to feed newly planted trees have not been successful. This is partly due to the greater need for water, and partly to the inadequate root system. Feeding may begin in the second year. A more desirable tree, such as oak, sweet-gum, or basswood, can be made to grow as fast as the "weed" trees, if properly fed.

SUMMARY

1. Tree feeding is the most important phase of intelligent tree care. It should be the starting point in any tree-preservation program.
2. Since it is impossible to determine which element may be the limiting factor, complete fertilizers containing nitrogen, phosphorus, and potash are needed. A complete fertilizer should contain nearly half nitrogen. A formula containing 10 per cent nitrogen, 8 per cent phosphorus, and 6 per cent potash has proved most effective in this vicinity.
3. The correct way to calculate the amount of fertilizer needed is to add the height in feet to the branch spread in feet to the trunk circumference in inches. The resulting figure is the number of pounds of 10-8-6 fertilizer needed.
4. The most effective time to feed a tree is between April 1 and July 1.

5. Dry fertilizers placed in punch-bar holes will not be so effective as if forced underground with water.
6. The amount of water available for use by trees is not so important as the concentration of fertilizer in that water. Well-fed trees show no sign of injury during a dry season.
7. Shade trees cannot be over-fed; they require large amounts of food. The requirements increase each year as the natural food supply decreases.
8. Since most of the elements needed for growth must be supplied by the soil, the only possible way to increase trunk diameter and increase twig growth is to supply the needed elements through fertilizing.
9. A tree may increase over a hundred pounds in dry weight a year. This growth evenly distributed over the tree will go unnoticed. The greater part of the dry weight increase must be supplied through the use of fertilizers.

A. P. B.

QUESTION BOX IN ADVANCED COURSE IN GARDENING

The advanced course in gardening for 1934 was completed on March 22, the hour being devoted to a question box and general discussion. The following list of questions, answered at this session, is interesting in that it indicates the type of difficulty experienced by the amateur in this region, as well as giving some idea of the scope of the course.

1. **Please indicate a simple procedure for determination of soil acidity (or alkalinity). Also quantitative analysis.**
2. **Please explain the Wherry soil classification system.**
3. **Explain the determining factors which make up the so-called "Upland field association"; the "moist oak association"; the "Juniper association", etc.**
4. **Please explain the idea of percentage of availability of the various constituents in inorganic fertilizers as expressed in the ratios 5-8-7, etc.**
5. **In gardening in the country, where lack of moisture is a great factor at certain times, would a superabundance of fertilizer**

(i.e., a soil rich in organic fertilizers) make up for the deficiency in water?

6. How often should lawns and flowers in St. Louis be watered and for how long a period?
7. What kind of cover crop should be sown on a hillside where the soil is naturally poor and exhausted by continuous working? To my knowledge no fertilizer has ever been put in the ground. There is at present corn on this plot.
8. I want to have a medium-sized pond for ducks. There is a naturally good situation for this pond at the base of a long, gently sloping hillside. How can we have a clear, attractive-looking pond on clay soil? The water will be still. Will it be stagnant?
9. Is it better in this climate to start perennials in May or in August?
10. What species or type of evergreens do best in this climate?
11. Can peat moss and sphagnum moss be used interchangeably?
12. Where—in the Americas and Europe—are the finest courses in landscape architecture given?
13. How can you keep a good stand of grass on a lawn which slopes rather steeply to the south?
14. How could you prolong the life of a 300-year-old black oak, now standing in a lawn? (It has a system of gravel trenches for watering.)
15. What does green moss on the bare spots in a lawn indicate? Acid? Poor soil?
16. How near a well-established privet hedge could you place a bed of tea roses?
17. How do you prune a wistaria vine that covers a porch and is almost up to the roof? Do you take out whole canes or can you cut back the whole vine to the height you wish?
18. What kind of ivy will cling to brick walls which have been painted white?
19. How can you prune 14- to 20-foot transplanted willows without destroying their shape?
20. What do you recommend to plant for a quick-growing shrub to be used as a screen?
21. What vines are good for rocky ground to be trained to walls? North side?
22. Do commercial fertilizers actually add nutriment to soil or do they hasten release of this nutritive value in soil—and will they eventually wear out soil?
23. Is there any way of telling male from female holly when not in bloom or berry?
24. In rocky location is it a good idea, if all the ground cannot be cultivated, to dig large holes where plantings are to be

made and put in good soil? What mixture of loam, sand, and leaf mold would be best?

25. Does bittersweet vine need particular care in this climate and will it cling to walls?
26. When is best time to plant fruit trees and what size does best? Also when is best time to prune established fruit trees?
27. Is it true that the Crataegus or thorn trees should be planted in Spring rather than Fall and why? Should they be balled and burlapped?
28. What is the name of the red-seeded iris that was displayed in the fall flower show?
29. Would you plant evergreen seedlings in a frame with lath for the first season?
30. What potatoes do you find best for this climate?
31. I read this statement in the "Flower Grower": "A Gladiolus bulb does not go to making division until it is already worthless from old age." Does this mean if you plant one bulb and harvest two that your gladiolus are too old?
32. How do you grow gladiolus bulbs? I have never been able to get any germinations.
33. How long does it take *Albizzia Julibrissin* to grow from seed to blooming size?
34. After an amaryllis blooms should you continue watering it till the foliage dies off naturally or should you stop the water at once? Should it be repotted in fresh dirt?
35. What is the best method of starting sassafras? We find it hard to transplant.
36. What is the best spray for peonies?
37. Please explain the best mulch for roses?
38. Should a rose bed be mounded, or even with the ground?
39. Is the gasoline treatment of dandelions as good as any?
40. What is the best way to get rid of a large patch of blackberries that have grown for many years? Under the bushes a good crop of blue grass has become established. Is it better to cut the bushes for several years and then plough, or plough immediately?
41. What are the best plants to grow on a rock wall with a northern exposure? It is a natural place for a wall, and will get sun until noon, since it is not wholly shaded.
42. What do you suggest to use as a border around a pond? 1. grass; 2. rough stones; 3. brick; 4. creeping plants? What is an easy method of making it look natural?
43. What type of lily may be propagated from seed with most ease in this climate?

44. In growing nelumbiums is it better to plant them on the bottom of the pond or in a box? How deep in water should they be planted? What variety is best suited to our climate?
45. A good fertilizer for (a) dahlias, (b) iris, and when is the best time to use?
46. How early should one use dusting sulphur on phlox which appeared to have mildew?
47. Is there any chemical treatment of the soil in a rose bed to prevent black spot? Would you advise digging up the bed and renewing soil, and to what depth should this be done?
48. Four years ago my peonies had root rot. Diseased parts were removed, roots washed, dusted with sulphur, and replanted in fresh soil. In two years half of the plants resumed their former health and bloomed well—others dwarfed, blossomed poorly or not at all. Will the latter eventually become healthy plants?
49. What broad-leaf evergreen shrubs, other than the holly, grow in the city? What is the rate of growth per year and the maximum height?
50. How are barberry and sweet-gum propagated?
51. What trimming does the gooseberry bush require?
52. What is best spray for Norway spruce?
53. When is the best time for dormant spraying?
54. What do they call suckers on roses?
55. Which is best, to cut off dry pods from cannas or leave them on?
56. When is proper time to trim barberry hedge?
57. Has a remedy been found for wilt in cucumber caused by bacilli of striped beetle? Is the White- or Black-Spine more hardy? Few cucumbers are raised in St. Louis County, but in adjoining counties the gardeners raise them successfully with only the use of lime or road dust. How about growing them under cloth?
58. Give a simple remedy for damping-off of seedlings. Why does this occur in a hot-house but not in a hot-bed?
59. Has the phase of the moon any influence on plants? Why then do transplants seem to take root and flourish at certain times while at other times under the same treatment and conditions they wither and fail to root?
60. Which is preferable, commercial fertilizer or barn-yard manure?
61. What temperature do you suggest for the amateur's greenhouse?
62. While of course different plants require different soils, what is your suggestion for potting soil? Sand, leaf mold, fertilizer, etc.

63. Give a list of hardy pot plants suitable for the amateur to grow in hot-house. How about pelargoniums?
64. This appeared in Walter Winchell's column, "Post-Dispatch," March 15: "Orchid seeds are so small . . . 30,000 of them weigh only as much as a grain of wheat! It takes *seven to ten years* for the first bloom to appear." Is he not all "wet"?
65. What is the trouble with a holly tree which gets brown spots on leaves and appears generally unhealthy? It had been watered well and kept in good condition.
66. What is good to plant between stepping-stones in clay soil? Plants can be watered. Have had bad luck with thyme.
67. Are these bugs leaf-hoppers?

NOTES

Dr. David C. Fairburn, Research Assistant at the Garden, spoke before the Belleville Garden Club, Belleville, Ill., March 28, on "Fertilizers and Seed Sowing."

Mr. Paul A. Kohl, Floriculturist to the Garden, gave an illustrated lecture on "The Iris," April 11, before Group 6 of the Webster Groves Home Garden Club.

Dr. Carroll W. Dodge, Mycologist to the Garden, was the speaker at the Washington University Association lecture, April 3. His subject was "Costa Rica, the Land of Coffee and Bananas."

Dr. David C. Fairburn, Research Assistant to the Garden, has published a paper, "Growth Responses of the Gladiolus as Influenced by Storage Temperature," as Research Bulletin No. 170, of the Iowa Agricultural Experiment Station.

Dr. George T. Moore, Director of the Garden, spoke on "Plants and People," before the Glendale Garden Club, at Kirkwood, March 23, and before the Brotherhood of Pilgrim Congregational Church, April 10.

The annual flower sermon, for which Henry Shaw made provision in his will, was preached at Christ Church Cathedral, April 15, by the Right Rev. George Craig Stewart, D. D., Bishop of the Diocese of Chicago.

Mr. L. P. Jensen, Manager Missouri Botanical Garden Arboretum, gave an illustrated talk before the Midland Valley Garden Club, at the Meadowbrook Country Club, Overland, Mo., March 26, on "Planning and Planting the Home Grounds."

Mr. George H. Pring, Superintendent of the Garden, gave a talk before the Wydown Men's Club, at the First Congregational Church, April 3, on "Planting City Gardens"; and before the St. Clair Garden Club, Belleville, Ill., April 11, on "Breeding of Tropical Water-lilies."

The first number of Vol. XXI of the ANNALS OF THE MISSOURI BOTANICAL GARDEN has recently been issued, with the following contents: "A Revision of the North American Species of the Genus Chorizanthe," by George J. Goodman; "A Monograph of the Genus Mentzelia," by Josephine Darlington; "Studies in Grindelia. I. New Species, Varieties, and Combinations of Grindelia," by Julian A. Steyermark.

Recent visitors to the Garden include: Mr. A. R. Wilson, of Cambridge University, Cambridge, England; Dr. Clare F. Cox, head biology department, Technical High School, Indianapolis, Ind.; Mr. Christofer, U. S. Commissioner of the Pribilof Islands, Alaska; Dr. Mildred E. Mathias, Research Associate, New York Botanical Garden; Dr. Harry J. Fuller, Instructor in Botany, University of Illinois, Urbana, Ill.; and Professor Norman McClintock, photo-naturalist and lecturer, of Rutgers College, Rutgers, N. J.

STATISTICAL INFORMATION FOR MARCH, 1934

GARDEN ATTENDANCE:

Total number of visitors.....19,278

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought.....	62
Total number of books and pamphlets donated.....	121

PLANT ACCESSIONS:

Total number of plants and seed packets donated.....	1,276

HERBARIUM ACCESSIONS:

By Purchase—

Degener, Otto—Plants of the Hawaiian Islands.....	127
Herter, G.—Plants of Uruguay.....	86
Lundell, C. L.—Plants of Central America.....	237
Williams, L. O.—Plants of Utah and Nevada.....	330

By Gift—

Berryman, Mrs. J. R.—*Ungnadia speciosa* Endl. from Mexico	1
Dodge, C. W.—Plants of Costa Rica.....	5
Jennings, O. E.—Plant of horticulture.....	1
Rapp, S.—Lichens of Florida.....	2
Steyermark, Julian A.—*Grindelia* from Texas and California	15
Thurston, H. W.—Plants of Brazil.....	2
Woodson, R. E., Jr.—Apocynaceae, etc.....	10
Zeller, S. M.—*Pestalotia* from Missouri.....	1

By Exchange—

Arnold Arboretum, Harvard University—Plants of the United States, collected by E. J. Palmer.....	440
Arnold Arboretum, Harvard University—Miscellaneous duplicates	13
Drouet, Francis—Plants of Oklahoma.....	36
Drouet, Francis—Algae of Massachusetts, etc.....	45
U. S. Department of Agriculture—Plants of Massachusetts, New York and British Columbia.....	4
U. S. National Museum—Lichens of Costa Rica.....	29
U. S. National Museum—Lichens of Colombia.....	124
University of California at Los Angeles by C. C. Epling—Plants of California and Lower California.....	199
Total	1,707

SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date to the death of Mr. Shaw, in 1889, the Garden was maintained under the personal direction of its founder, and, while virtually a private garden, it was, except at certain stated times, always open to the public. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was designated by Mr. Shaw as its official title and in his will or in any of his writings he specifically referred to it as the "Missouri Botanical Garden." By a provision of Mr. Shaw's will the Garden passed at his death into the hands of a Board of Trustees. The original members of the Board were designated in the will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will, the immediate direction of the Garden is vested in a Director, appointed by the Board of Trustees. The Garden receives no income from city or state, but is supported entirely from funds left by the founder.

The city Garden comprises 75 acres, where about 12,000 species of plants are growing. There is now in process of development a tract of land of over 1,500 acres outside the city limits which is to be devoted to (1) the propagation and growing of plants, trees, and shrubs, designed for showing either indoors or outside, at the city Garden, thus avoiding the existing difficulties of growing plants in the city atmosphere; (2) gradually establishing an arboretum as well as holding a certain area as a forest reservation, with the idea that possibly at some future time this may become the new botanical garden.

The Garden is open to the public every day in the year, except New Year's Day and Christmas—week days from 8:00 a. m. until one-half hour after sunset; Sundays from 10 a. m. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Place, on the Sarah car line (No. 42). Transfer south from all intersecting lines. The Garden may also be reached by Bus Route No. 99, to which all other motor-bus lines transfer.

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Missouri Botanical Garden Bulletin

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PAGODA TREE (SOPHORA JAPONICA)

Missouri Botanical Garden Bulletin

Vol. XXII MAY, 1934 No. 5

SEMI-EVERGREEN TREES

The winter landscape of a smoke-laden city is unenlivened by a single bit of green foliage. Here and there a few blackened conifers are left; but they resemble dead trees, very little color showing through the thick cover of soot. It is generally supposed that evergreens cannot be grown in a smoky atmosphere, and that we must be thankful for the "weed trees", the soft maple, sycamore, and poplar, whose only claim to distinction is that they bear some sickly foliage each summer. A tree clothed in summer foliage until mid-November, or later, would be most welcome in a city of stark, horribly trimmed trees. Fortunately, there are at least four trees whose semi-evergreen character would shorten the leafless period of winter.

Foremost among trees of semi-evergreen habit is the pagoda tree (*Sophora japonica*). It remains in full leaf (pl. 38) longer than any other large tree in the Garden. During the month of August it bears large clusters of white flowers of particular interest to nectar-loving insects. Thirty years of city residence have proven its hardiness, and during that time it has shown itself to be without a single objectionable habit as a city tree.

Second in importance is the English elm (*Ulmus campestris*). It retains its leaves until freezing weather, in some seasons this being almost a month later than the American elm. It should prove a very satisfactory tree for street use; the narrow pyramidal form would discourage pruning, and it is without insect enemies. However, the habit of developing root suckers might limit its use to lawns and parks.

The spindle tree of China (*Evonymus Bungeana*) remains in active growth until a killing frost. As the leaves are shed the bright orange and red fruits become visible. It is a low, spreading tree, forming a dense mass of green, and might be used wherever space is limited.

Of the North American trees none remain in foliage longer than the soapberry tree (*Sapindus Drummondii*). After the leaves have been shed the beautiful clusters of golden fruits attract attention, until they turn black in late January. It is much used as a street tree in some parts of the Southwest, but even in the Garden it holds its green leaves longer than the maples. Due to its small size it should be used only as a lawn tree.

The trees described will add no color except green to the city landscape in the fall. Perhaps it is too much to ask for a street lined with flaming oaks or golden ginkgoes. However, the use of any tree, other than the "weed trees," will greatly increase the beauty of the city in winter.

A. P. B.

SUMMER CARE OF CACTI

In the past few years the public has gone "cactus crazy." This enthusiasm for succulent plants probably started in 1929, when the department stores in the larger cities featured these grotesque plants of the desert at ten cents apiece and up. At the present time cacti and other succulent plants have become such favorites with amateur growers that truck loads of them have been carted away from their native habitat. The situation has reached such a point that several

1
"GOLDEN BARREL" CACTUS PLANTED
AMONG OTHER SUCCULENTS

2
A CACTUS BED

TWO BEDS OF CACTI FORMERLY PLANTED AT THE GARDEN

of the southwestern states have passed laws to stop this wholesale destruction of the desert's flora.

In the February, May, and September, 1933, numbers of the Garden BULLETIN attempts were made to assist the amateur grower to solve some of the various problems which beset him. The general culture of cacti, growing succulents from seed in the home, and the winter care of cacti were dealt with, and now the summer care of these plants remains to be treated.

In the Middle West the month of April generally brings delightful weather (though frosts are still likely), and all succulent plants welcome the change from the air of the house to the fresh breezes of spring. Cacti may be set out on an open porch as early as the first day of April, in order that they may gradually recover from their unfavorable winter experience. They should be covered on very cool nights, and when frost is predicted should be taken inside and kept there until the danger of frost is past.

During the early part of May cactus plants may be set outdoors for the summer, either in rockeries, in beds, or in borders. A slope provides an ideal opportunity for a rockery. However, the level ground of most city yards necessitates the building of an artificial rockery which frequently fails to fit into the surroundings. Never build a rockery in the shade of trees, as succulents delight in full sunlight. An unshaded place usually can be found in a corner of the yard, near the garage, near the ashpit, or possibly in the curve of the border.

The best rocks for a cactus rockery are those which are porous and absorbing of moisture, such as the sandstone and limestone found in the Middle West. The honeycombed rock so eagerly sought for rock gardens because of its porous nature is admirable, but any kind of rock can be used, even boulders. The soil in a rockery for succulents should be of a light sandy consistency. As for the grouping of such plants, there is no set rule.

Planting cacti directly in the ground is not recommended because of the danger of injuring the roots when digging them up for the winter removal indoors. It is better to leave them potted and to plunge the pots in the soil to within a half-inch of the rim. Gravel or limestone chats may be used as a ground cover to conceal the pot rims. Plants exposed to sunshine and rain during the summer months will do far better than those kept indoors. The beauty of a rockery of semi-tropical and tropical cacti can be increased by a permanent planting of some of our hardy succulent plants, such as the prickly pears, the native sedums, and talinums (pl. 39).

On account of their symmetry and ease of culture, some attractive designs may be formed with cacti in beds (pl. 40).

Cactus plants may be watered daily in the summer, if the weather is fine, and they may also be frequently syringed. It is a mistaken idea that they can live without water—in fact during the summer months they will stand a great deal of water, and if they get it there is much better growth. Summer rains are often not sufficient to wet the soil of a pot plant thoroughly, and artificial sprinkling must be resorted to. Of course the cacti planted directly in the soil will not require so much watering as the potted plants, unless the ground becomes very dry.

Weeds will tend to grow among the cacti, and it is not always easy to remove them, for they are liable to appear in the spiniest and prickliest part of the bed. Pull them out when young, and avoid trouble afterward. Cacti grow to best advantage during the exceptionally hot weather of July and August. When treated as indicated above they will stand a better chance of surviving the trying winter months.

L. C.

BULBS

Previous articles by Mr. A. G. Ulrich, which appeared in the October, 1932, and May, 1933, numbers of the BULLETIN

dealt with special kinds of bulbs. The following general article on the subject includes the results of Mr. Ulrich's personal experience, which cannot help but be of value to those interested.

"The gardener, and even the casual observer, must have noticed that bulbous plants are prominent among the flowers which bloom early in the season. Winter aconite, snowdrop, crocus, scilla, chionodoxa, narcissus, fritillaria, anemone, hyacinth, and tulips are among the treasures of the spring garden. While some of these are not strictly bulbous plants, they have either bulbous, tuberous, or enlarged form of root or underground stem. There are three kinds of bulbs: the coated, such as the hyacinth, onion, etc., where the scales are large and fold around each other; the scaly, of which the lily is the best example, composed of fleshy scales, narrow, and united at the base; the solid, which might be considered rounded tubers, consisting of a solid, white, farinaceous mass, the gladiolus and crocus being familiar types. Popularly speaking, any solid underground stem is called a bulb, and under this designation are included many true tubers which possess very little of a bulbous nature. A very familiar example is the tuberose, *Polianthes tuberosa,* so named on account of its tuberous root, and not, as is commonly considered, from being a rose with a tube.

"Although generally considered a root, a bulb partakes more of the nature of a seed, since it contains starchy matter which serves as nourishment for the young plant, and when planted sends forth roots into the earth and an ascending shoot to the air. However, unlike the seed, which wastes away after giving birth to the plant, the bulb remains the same to all outward appearance. This is only apparent, however, for every year the old bulb tissue is consumed by the plant and replaced by new, but often in such a manner as to be scarcely noticeable. Seeds send up stems which produce leaves and branches, or buds which develop as such, but a bulb sends up only leaves and a flower stem.

"Some bulbs produce small bulbs or bulblets in the axils of the leaves, the tiger lily (*Lilium tigrinum*) being an example. Sufficient nourishment must be stored in the bulbs for the development of leaves and flowers. The length of time required to perfect this process varies with the different species, and in the same species in many instances, according to mode of growth and circumstances. Some bulbs and tubers require years before sufficient nutrient material is accumulated; others only several months. The manner in which this store is laid up is the same as that in which all plants assimilate the elements of earth, air, and water. It is effected by means of the roots and foliage and differs only in the place of deposit. In all bulbs, tubers, and fleshy root-stalks, this nutriment is laid up in the earth and the leaves usually die annually or take a season of rest, but without a full development of foliage a perfect flower is not to be expected. If the leaves were to be cut off as they appeared the bulb would die, and they should never be removed until they turn brown or wither.

"Every bulb requires a season of rest, generally after blooming, when sufficient nourishment has been stored for next year's growth and ripening of seed. The foliage turns yellow and falls off (except in evergreen bulbs which remain green without growth), and the bulb appears fresh but shows no sign of vitality. The season of rest varies in time and duration. In some it can be regulated indefinitely, that is the bulb can be forced to bloom at any season, while in others perfect flowers can be produced only at certain seasons. Early-flowering bulbs, such as crocus, Persian iris, fritillarias, snowdrops, tulips, hyacinths, etc., rest from July until October, after which their roots begin to grow but the leaves do not appear until spring. Lilies rest immediately after flowering and the bulbs seldom grow until late in spring, except *Lilium candidum* and its varieties, which make their growth of leaves in autumn and bloom in early summer. Varieties of polianthes, narcissus, and *Iris susiana* generally

start to grow in the fall, and if not well protected the young growths are killed by frost and the bulbs die.

"Some bulbs bloom late in the fall and perfect their growth of foliage and seed the following spring, Colchium being an example. In some, as the Jacobean lily (*Sprekelia formosissima*) and the Belladonna lily (*Amaryllis Belladonna*), the flower stalk appears before the leaves, while in others, for example, the tall white star of Bethlehem (*Ornithogalum pyramidale*) the flower stalk pushes up after the foliage decays. *Lycoris squamigera* (*Amaryllis Hallii*) makes a leaf growth in early spring which matures in June. The flower scape appears in August, after the leaves have died, and in a few days attains a height of two or more feet. A bulb sent to me from Louisiana (*Hymenocallis Caymanensis*) makes a leaf growth in spring, the leaves dying off in early summer and the flower scape appearing immediately afterwards. In such bulbs as the hyacinth and narcissus, the individual flower stalks rise from the center of the crown of leaves, while in Amaryllis (Hippeastrum), they are produced from the side of the bulb and the leaves from the top. These two habits of growth occur in the same family. In the Crown Imperial (*Fritillaria Imperialis*) the flower and the foliage may be on the same stalk. Such peculiarities of growth are infinite, and furnish much of the pleasure derived in the culture of flowers.

"We have seen that each bulb requires a season of rest. Most bulbs are taken out of the earth for that time so as to keep them perfectly dry. Evergreen bulbs are of course never entirely dried off but only enough water given to keep the leaves from fading and the bulbs from shriveling. Great care must be taken not to dry up the small bulbs, and the degree of dryness each kind of bulb requires is best learned by experience. Some bulbs do better if taken from the ground when they have made their growth and kept until the season for replanting. This is the practice with Holland bulbs. Others do far better if left in the ground undisturbed for some years.

"I have said that the old bulb is consumed each year and a new one formed. This is done in many ways. Sometimes the new growth is formed in the center of the bulb, as in the hyacinth, sometimes at the side, as in the tulip, sometimes at top, as the crocus and gladiolus, and sometimes on the bottom, as the bulbous iris. The crocus grows out of the ground each year, the iris buries itself, and the tulip moves away from its position by the development of lateral roots which subsequently contract. These bulbs are often pulled to an appreciable distance from their parent and gradually by yearly steps are spread over a considerable area. Kerner quotes an interesting illustration of this process. Some soil containing bulbs of *Tulipa sylvestris* was once put in a garden in Vienna, in the middle of a grass plot shaded by a maple tree. As the grass was mowed every year before the flowers opened, there was no formation of seed and the tulips could only multiply by offshoots. After about twenty years, the lawn was covered with tulip leaves which arose from underground bulbs, occupying an area of ten feet in diameter. Thus in the time mentioned the pull of the contracting roots had caused the bulbs to spread for about five feet in all directions. Fleshy root-stalks also move, the new bulb being produced beyond the old one. This is a reason for taking them up occasionally and removing them to another location. Many are lost for want of this simple precaution. Another cause of failure is that the bulb often begins to grow prematurely.

"Bulbs are propagated by offsets, produced at the base of the root or parent bulb, in the axils of the leaves, and occasionally as flower buds, which soon produce flowering plants. They are also raised from seed but flowering plants are seldom produced in less than three years. Scaly bulbs are propagated by planting the scales in sand, each scale eventually producing a new bulb. Hyacinths, gladiolus, and other bulbs are occasionally increased by cutting up the old bulb, each portion producing new shoots and roots. The first two methods are natural, while the last two depend upon the skill of the gardener."

DENDROBIUM SUPERBIENS

The following note from Mr. Gurney Wilson, the Garden's Representative in Europe, refers to the article in the December, 1933, number of the Garden BULLETIN. He calls attention to the fact that Fitzgerald, the father of Australian Orchidology, was the first to suggest the hybrid nature of *Dendrobium superbiens.*

The notes on *Dendrobium superbiens* have no doubt been read with interest by the many orchid folk who have hitherto regarded the plant as a species. That *D. superbiens* is a hybrid between *D. Phalaenopsis* and *D. undulatum* has been definitely proved by the seedlings raised in the Missouri Botanical Garden.

The recording in 1932 of hybrids of similar parentage under the respective names "Pauline" and "Greystone" brought forth a note from Mr. R. F. Leaney that he had discovered "Pauline" in the form of a natural hybrid, in places that in the past have been simply covered with *D. Phalaenopsis* and *D. undulatum.*

Reference may here be made to *D. Leeanum,* originally described as a species, but which Rolfe subsequently suggested might be a natural hybrid between *Phalaenopsis* and *superbiens,* as it combines the characters of both. At a much later period Viscount Sohma sent to England a series of water-colour drawings of 41 flowers of hybrids between *D. Phalaenopsis* and *D. superbiens* that had been raised at Tokyo. They were described in the "Orchid Review," 1923, p. 355, where it is remarked: "One is astonished at seeing such a wide variation in their form and colour. They present a variation greater than is generally produced by the crossing of two species of undoubted purity. We are led to enquire more deeply into the constitution of the *superbiens* parent: is it a true species or a natural hybrid?"

D. superbiens was originally described by Reichenbach in 1876, with the remark: "This very curious novelty was imported by Messrs. Veitch, from Northern Australia, and is, no doubt, the best Dendrobe that ever came from that rich part of the world."

Although it is only recently that the hybrid character of *D. superbiens* has been definitely ascertained, it is much to the sagacity of Fitzgerald that at a very early date in the plant's history he suggested its hybrid character. His monumental work "Australian Orchids" contains a coloured plate of *D. superbiens,* dated August, 1879, and this, with the descriptive text, was issued under date of January, 1884. As the book, a weighty volume of folio size, is rarely accessible for reference, Fitzgerald's description of *D. superbiens* may prove of interest: "The habit, form of the flowers generally, and especially of the labellum and column, would almost lead to the conclusion that this beautiful Dendrob is a variety of

D. undulata, and the less robust growth and colour of the flowers, to the supposition that it has arisen from hibridisation between *D. undulata* and *D. bigibbum*, or some other of the lilac species found in Australia." He adds that "a plant in the possession of Capt. Broomfield continued in flower for thirteen months, producing at least twelve spikes at a time, the individual flowers lasting three months."

(The spelling of the above words: Dendrob, hibridisation, undulata, is as given by Fitzgerald).

NOTES

The University of Kansas School of Pharmacy visited the Garden, May 5.

Miss Virgene Warbritton, teacher of botany, Monett Junior College, Monett, Mo., accompanied her class on a visit to the Garden library, herbarium, and grounds, May 5.

Dr. J. M. Greenman, Curator of the Herbarium, spoke before the St. Louis Academy of Science, April 25, on "Thomas Nuttall and the Wyeth Expedition of 1834-35."

Mr. Paul A. Kohl, Floriculturist to the Garden, spoke before the St. Louis Horticultural Society, May 4, on "Gardens of the Pacific Northwest."

Mr. L. P. Jensen, Manager Missouri Botanical Garden Arboretum, spoke at Rolla, Mo., May 9, before the Hub Club, on "The Missouri Botanical Garden Arboretum," and before the Rolla Garden Club, on "Landscape Gardening."

Dr. George T. Moore, Director of the Garden, attended the meetings of the American Philosophical Society, at Philadelphia, April 19-21. While in Philadelphia he gave the Sunday Chapel address to the students of Girard College, April 22.

Recent visitors to the Garden include Mr. Howard Corning, director of the Essex Institute, Salem, Mass., and Mrs. Corning; Dr. Edgar T. Wherry, professor of ecology, University of Pennsylvania; Dr. F. M. Fryxell, professor of geology, Augustana College, Moline, Ill.; Dr. A. L. Bakke, professor of plant physiology, Iowa State College, Ames, Iowa.

Mr. George H. Pring, Superintendent of the Garden, has given the following talks recently: "Orchid Exploration," before the Professional Women's Club of the Second Presbyterian Church, April 27; "Water-lilies," before the Emerson School Mothers' Club, May 2; "Plant Curiosities," before the Rotary Club of Webster Groves, May 4; "Orchid Exploration" before the Women's Advertising Club of St. Louis, May 7.

STATISTICAL INFORMATION FOR APRIL, 1934

GARDEN ATTENDANCE:

Total number of visitors.....34,238

LIBRARY ACCESSIONS:

Total number of books bought..... 7
Total number of books and pamphlets donated..... 216

PLANT ACCESSIONS:

Total number of plants and seed packets donated..... 1,613

HERBARIUM ACCESSIONS:

By Purchase—

Degener, Otto—Plants of the Hawaiian Islands..... 94
Lundell, C. L.—Plants of British Honduras..... 57
Steyermark, Julian A.—Plants chiefly from northern Missouri 1,184

By Gift—

Dodge, C. W.—Plants of tropical America..... 2
Greenman, J. M.—Plants of Missouri..... 2
Hanna, L. A.—Plants of Wyoming and Colorado..... 184
Hills, Mrs. William A.—*Lamium amplexicaule* L. from Illinois 1

By Exchange—

Ewan, Joseph—Plants of California..... 40

Total 1,564

SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date to the death of Mr. Shaw, in 1889, the Garden was maintained under the personal direction of its founder, and, while virtually a private garden, it was, except at certain stated times, always open to the public. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was designated by Mr. Shaw as its official title and in his will or in any of his writings he specifically referred to it as the "Missouri Botanical Garden." By a provision of Mr. Shaw's will the Garden passed at his death into the hands of a Board of Trustees. The original members of the Board were designated in the will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will, the immediate direction of the Garden is vested in a Director, appointed by the Board of Trustees. The Garden receives no income from city or state, but is supported entirely from funds left by the founder.

The city Garden comprises 75 acres, where about 12,000 species of plants are growing. There is now in process of development a tract of land of over 1,500 acres outside the city limits which is to be devoted to (1) the propagation and growing of plants, trees, and shrubs, designed for showing either indoors or outside, at the city Garden, thus avoiding the existing difficulties of growing plants in the city atmosphere; (2) gradually establishing an arboretum as well as holding a certain area as a forest reservation, with the idea that possibly at some future time this may become the new botanical garden.

The Garden is open to the public every day in the year, except New Year's Day and Christmas—week days from 8:00 a. m. until one-half hour after sunset; Sundays from 10 a. m. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Place, on the Sarah car line (No. 42). Transfer south from all intersecting lines. The Garden may also be reached by Bus Route No. 99, to which all other motor-bus lines transfer.

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Missouri Botanical Garden Bulletin

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PLANTS TREATED WITH ARTIFICIAL LIGHT (LEFT) COMPARED WITH UNTREATED PLANTS (RIGHT): 1. TRACHYMENE CAERULEA, (BLUE LACE FLOWER). 2. SALPIGLOSSIS SINUATA (PAINTED TONGUE). 3. CALENDULA OFFICINALIS (POT MARIGOLD).

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ARTIFICIAL LIGHT AND PLANT GROWTH

Within recent years considerable attention has been given to the influence of the relative lengths of day and night on plant growth. Although not all plants respond favorably to controlled illumination, a large number have been successfully treated and are now designated as "short-day" and "long-day" plants, according to their specific light requirements. Chrysanthemums, poinsettias, stevias, and others, which normally mature during the short days of fall and winter, may be stimulated into early flowering by shading with black cloth to reduce the daylight period. Snapdragons, asters, and gladioli, which mature in the spring and summer when the days are long, can be forced into vigorous growth and pre-season flowering by using electric light to supplement the short days of winter. These cultural methods are rapidly being adopted by commercial flower growers and no doubt soon will become common practice in the modern greenhouse routine.

Experiments with artificial light at the Missouri Botanical Garden have shown marked results with *Trachymene caerulea, Calendula officinalis, Salpiglossis sinuata, Matthiola incana, Chrysanthemum frutescens,* and various Pelargoniums. Well-established plants in 6-inch pots were used, one series receiving electric light in addition to the daylight while the check series received only the regular daylight. The treated plants were exposed to four hours of electric light

from 6 p. m. to 10 p. m. for thirty days (April 15 to March 15), a few weeks prior to the usual flowering season. The electric lamps, 100-watt, were suspended 2½ feet above the tops of the plants to exclude to a certain extent the effects of heat radiation. The treated and check plants were photographed at the end of the thirty-day period.

The most striking growth responses occurred with *Trachymene caerulea*, *Salpiglossis sinuata*, and *Calendula officinalis* (pl. 41). The top growths of the plants exposed to the electric light were decidedly more vigorous, and flowers of excellent quality were produced two to three weeks in advance of the check plants. The artificial light also increased considerably the length of the flower stems. The stimulatory effects of the electric light were reflected in the growth responses of the treated plants for several weeks after the experiment was discontinued.

D. C. F.

OLD TREES IN THE GARDEN

The removal of a sassafras tree 106 years old from the mausoleum enclosure has again focused attention on the age of the old trees in the Garden. It was reported in the BULLETIN of March, 1932, that the pin oak east of the floral display house was perhaps the oldest native tree in the Garden, but the sassafras referred to must have seen almost as many summers. As is generally the case in old trees, the hollow trunk precluded the possibility of obtaining an accurate check on its age. However, it had flourished and grown to maturity long before it found itself living within the city limits. The sassafras seldom grows as an individual, due to its habit of developing new trees from root suckers. It is not unlikely, then, that sassafras trees have occupied this particular bit of soil for several hundred years. What an unfailing source of supply for "spring tonic"!—who knows how much bark the early villagers may have dug here for just that purpose!

Despite its frequent appearance in abandoned fields in Missouri, large and old specimens are rare. Very few attain

a height of 40 feet, and the trunk diameter of the Garden specimen of 31 inches must be very near the maximum attained by sassafras.

In addition to the pin oak referred to above only one other tree is large enough to have been growing here before this became Mr. Shaw's Garden. This is a sycamore just west of the iris garden. It is 87 feet high and continues to grow vigorously, though it has been struck by lightning three times in seven years. A. P. B.

TREE CURIOSITIES AT THE ARBORETUM

An Unusual Elm.—The accompanying photograph (pl. 42, fig. 2) shows a composite tree of an American elm, *Ulmus americana* L. Many years ago the original tree was cut off near the ground. Adventitious buds on the stump or roots sprouted and grew into eleven stems. These stems now form individual trees, which combined have a circumference of thirty-six feet at four feet from the ground. The height of the group is approximately seventy-five feet.

Peculiar Growth on Walnut.—Many years ago this black walnut (*Juglans nigra* L.) was evidently struck by lightning (pl. 42, fig. 3). A section of the wood was loosened at the top and forced downwards as shown in the accompanying illustration. This continued to grow and it is now two feet five inches long and covered with bark. The tree is five feet four inches in circumference three feet from the ground, and approximately sixty feet high, the first branch being seven feet four inches from the ground. From this point downwards is a well-defined ridge in the bark, showing the path of the lightning. It is unusual to find the bark on a splintered piece of wood continuing to grow in a downward direction. L. P. J.

NUT TREES IN THE GARDEN

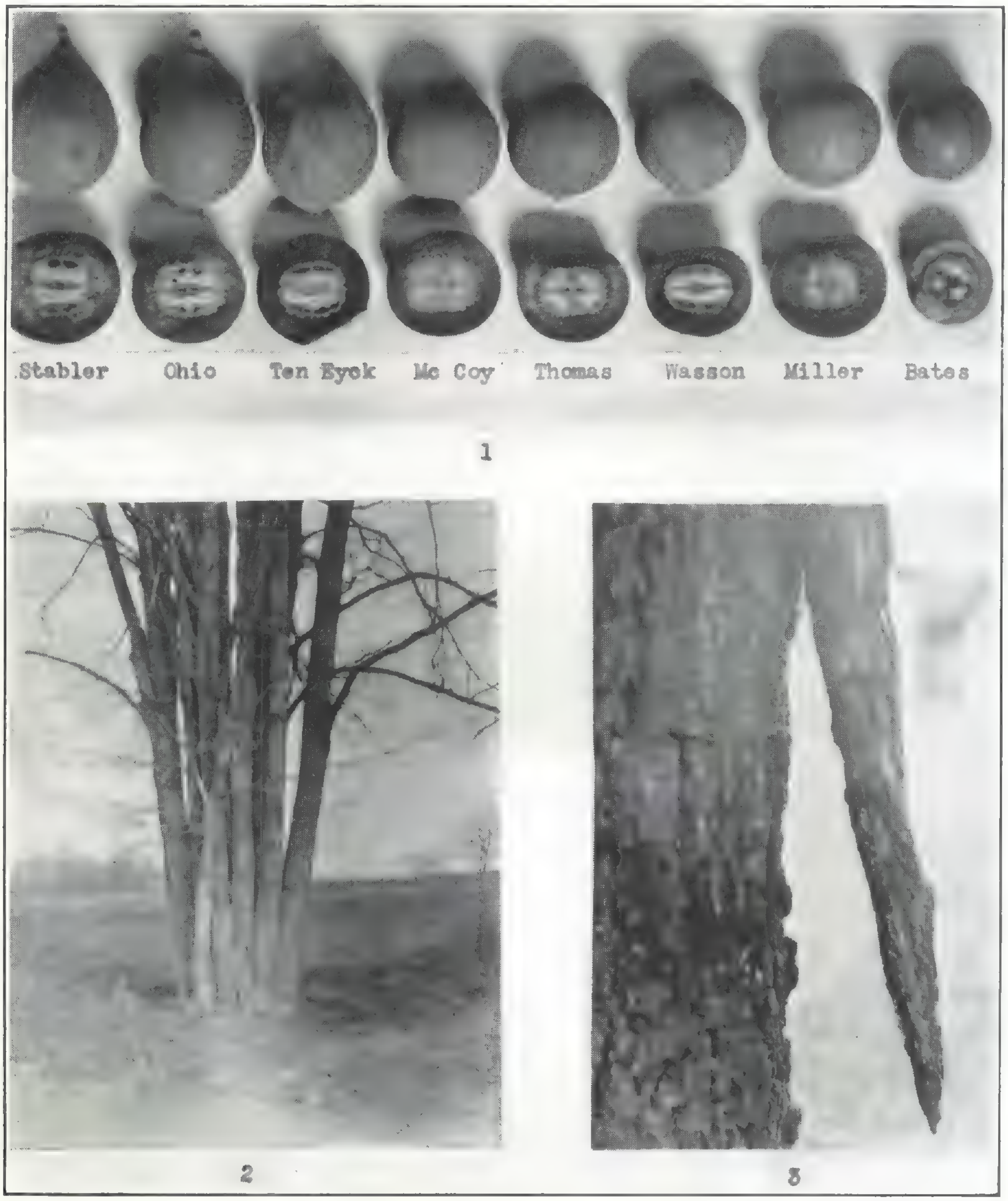
The BULLETIN, of October, 1919, described the planting of a variety nut orchard at the Missouri Botanical Garden, which was the "first attempt to collect and test all varieties

of nuts hardy in St. Louis." At that time the following varieties, in groups of three and four trees each, were planted:

Black walnuts—Miller, Ohio, Thomas, Stabler, Lancaster, Ten Eyck, Kinder, Wasson, and McCoy.
Persian walnuts—Bates, Wiltz Mayette, Vrooman Franquette, Rush, and Alpine Mammoth.
Japanese walnuts—Lancaster.
Hickories—Kirtland, Stanley, Pleas hybrid (pecan x bitternut), Beaver hybrid (bitternut x shagbark), and Siers hybrid.
Pecans — Busseron, Indiana, Posey, Niblack, McAllister, Butterick, Marquard, Warrick, Major, Kentucky, and Greenriver.

The first trees to bear were the Persian walnuts. Just three years after they were planted one tree of "Vrooman Franquette" bore five nuts, and one tree of "Rush" bore two. These were followed by a "Siers" hickory and a "Major" pecan which bore three nuts. Since that time all the pecans, hickories, and Persian walnuts, except one tree of the Persian walnut "Bates," have died. Starvation, if not the primary cause, has contributed to the death of all of them. After 1922 the growth rate declined steadily, and in 1929 the terminal twig growth was less than three inches a year. This, of course, upset the bearing habit of the trees and they failed to produce fruit. In 1929 an intensive tree-feeding experiment was begun, which included the nut orchard, and by 1932 the growth of these trees had increased to such an extent that they bore five bushels of nuts. The single tree of the Persian walnut "Bates" bore twenty-eight nuts that year.

In 1933 the squirrels became acquainted with the orchard and succeeded in harvesting the crop, which was smaller than that of the previous year. Since most nut trees bear in alternate years, it is expected that in 1934 a sizeable crop will be harvested; at least, more flowers were evident than in any previous spring.



1. FRUITS OF BLACK WALNUTS GROWN AT THE GARDEN, ABOUT ONE-HALF NATURAL SIZE. 2. COMPOSITE AMERICAN ELM AT THE ARBORETUM. 3. GROWTH ON A WALNUT TREE AT ARBORETUM.

Originally the area between the trees was used as an experimental grass plot; culturally then the orchard was in the "sod system." In the fall of 1930 the sod was plowed under and rye was sown, and in June the rye was in turn plowed under and soy beans were sown. Thus the cultural system was changed to one of "winter cover, green manuring." In 1929 a total of 85 pounds of commercial fertilizer was used on this orchard. During 1930 the amount of fertilizer was 93 pounds, and was increased to 208 pounds in 1931. Another increase brought the total to 420 pounds for 1932. In 1933 only 490 pounds were used, since a greater amount would have increased the vegetative growth at the expense of fruit production. It is of interest to note that the rejuvenation of this orchard has been accomplished during three very dry years, during which no form of irrigation was practiced.

A detailed description of the flavor, size of kernel and cracking quality of nuts can be obtained from many sources, but it will not be amiss to record some of the differences in the fruit taken from this experimental orchard. "Stabler" (pl. 42, fig. 1) is the largest of the elongate type of black walnut, full kernel and thin shell; "Ohio" has a slightly heavier shell and rougher husk; "Ten Eyck" is smaller in size, but with full kernel and thin shell; "McCoy" is the largest of the round type, with very heavy shell and small kernel; "Thomas" is quite similar except for a thinner shell; "Wasson" is the smallest elongated type, but with large full kernel and thin shell; "Miller" is very small, but has a thin shell and full kernel: "Bates" has a heavy shell and small kernel.

In vigor and habit the trees show very few differences which would affect their value commercially. "Ten Eyck" and "Ohio" are large open-headed trees; "Stabler" is more compact. "Miller" is more open than any of the round-fruited types, and "Wasson" the most compact of the elongated types. Any of these types might be used ornamentally, since they have proven their hardiness and their ability to bear when quite young.

A. P. B.

NOTES

Mr. G. H. Pring, Superintendent of the Garden, supervised the installation of the water-lily collection in the Horticultural Hall at the Century of Progress Exposition, Chicago.

Mr. Pring gave a talk before the Mid-West Horticultural Society at Chicago, May 25, on "Orchid Exploration."

The June number of the "Garden Digest" contains extracts from Mr. Pring's article in the March BULLETIN, on "Hybrid Nymphaeas."

Mr. L. P. Jensen, Manager Missouri Botanical Garden Arboretum, is the author of an article in the "Missouri Magazine," Vol. 6, No. 12, entitled "Protect Wild Flowers of the Ozarks."

Mr. P. A. Kohl, Floriculturist to the Garden, spoke before the Alpha Delphian Society of St. Louis at the Garden, May 21, on "Iris, Peonies, and Roses"; after which he conducted the members on a tour of the Garden.

Recent visitors to the Garden include: Dr. Charles Thom, Principal Mycologist, Bureau of Chemistry and Soils, Washington, D. C.; Mr. Reginald T. Townsend, Editor "Country Life," New York City; Dr. Harry J. Fuller, Instructor in Botany, University of Illinois, Urbana; and Mr. Clarence T. Pedlow, Superintendent of Parks, Rockford, Ill.

Mr. L. P. Jensen spoke before the members of the Cape Girardeau Garden Club, May 19, when they were guests at the Arboretum, on "The Missouri Botanical Garden Arboretum;" and before the St. Louis Naturalists' Club and the St. Louis Wild Flower Club, May 26, on "Roadside Planting and Improvement."

The second number of Vol. XXI of the "Annals of the Missouri Botanical Garden" has been issued, with the following contents: "Protogaster, Representing a New Order of the Gasteromycetes," by S. M. Zeller; "Certain Physical and Structural Properties of Three Species of Southern Yellow Pine Correlated with the Compression Strength of Their Wood," by Earl E. Berkley; "*Poria Cocos* (Schw.) Wolf, Found on a Railroad Tie in Service," by Earl E. Berkley; "Field and Herbarium Studies, III," by Louis Williams;

"*Posadasia pyriformis* and *P. capsulata,* Two Causative Organisms of Darling's Histoplasmosis in the United States," by Morris Moore; "A New Geotrichum from a Bronchial and Pulmonary Infection, *Geotrichum versiforme* Moore, n. sp.," by Morris Moore; "The Effects of Increasing the Iodine Content of the Tomato Plant on Respiration and Enzymatic Activity," by F. Lyle Wynd.

STATISTICAL INFORMATION FOR MAY, 1934

GARDEN ATTENDANCE:

Total number of visitors.....26,586

LIBRARY ACCESSIONS:

Total number of books bought..... 34
Total number of books and pamphlets donated..... 451

PLANT ACCESSIONS:

Total number of plants and seed packets donated..... 285

HERBARIUM ACCESSIONS:

By Purchase—

Steyermark, Julian A.—Plants of Missouri..... 31
Weigel, Theo. Oswald—Weese, "Eumycetes selecti exsiccati," Fascs. XXVII and XXVIII, Nos. 651-700..... 50

By Gift—

Bettis, Mrs. James R.—Plants of Missouri..... 6
Billings, F. H. — *Cryptoporus volvatus* (Peck) Shear from California 1
Lahman, Mrs. C. E.—Cacti of Oklahoma..... 3
Larsen, Miss Esther L.—Plants of Delaware..... 82
Lundell, C. L.—Plants of Central America..... 5
Martinez, Eduardo, Jr. — Plants of Colombia, South America 5
Meyer, Ernest H.—Plant of horticulture, *Tamarix gallica* L. 1
Steyermark, Julian A.—Plants of central United States. 10
Williams, L. O.—Plants of Missouri..... 18

By Exchange—

Maguire, Bassett—Plants of Utah..... 38
U. S. National Museum — Lichens of Colombia, South America 35

Total 285

SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date to the death of Mr. Shaw, in 1889, the Garden was maintained under the personal direction of its founder, and, while virtually a private garden, it was, except at certain stated times, always open to the public. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was designated by Mr. Shaw as its official title and in his will or in any of his writings he specifically referred to it as the "Missouri Botanical Garden." By a provision of Mr. Shaw's will the Garden passed at his death into the hands of a Board of Trustees. The original members of the Board were designated in the will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will, the immediate direction of the Garden is vested in a Director, appointed by the Board of Trustees. The Garden receives no income from city or state, but is supported entirely from funds left by the founder.

The city Garden comprises 75 acres, where about 12,000 species of plants are growing. There is now in process of development a tract of land of over 1,500 acres outside the city limits which is to be devoted to (1) the propagation and growing of plants, trees, and shrubs, designed for showing either indoors or outside, at the city Garden, thus avoiding the existing difficulties of growing plants in the city atmosphere; (2) gradually establishing an arboretum as well as holding a certain area as a forest reservation, with the idea that possibly at some future time this may become the new botanical garden.

The Garden is open to the public every day in the year, except New Year's Day and Christmas—week days from 8:00 a. m. until one-half hour after sunset; Sundays from 10 a. m. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Place, on the Sarah car line (No. 42). Transfer south from all intersecting lines. The Garden may also be reached by Bus Route No. 99, to which all other motor-bus lines transfer.

STAFF
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Missouri Botanical Garden Bulletin

Vol. XXII SEPTEMBER, 1934 No. 7

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AND THE BOARD SO CONSTITUTED, EXCLUSIVE OF THE
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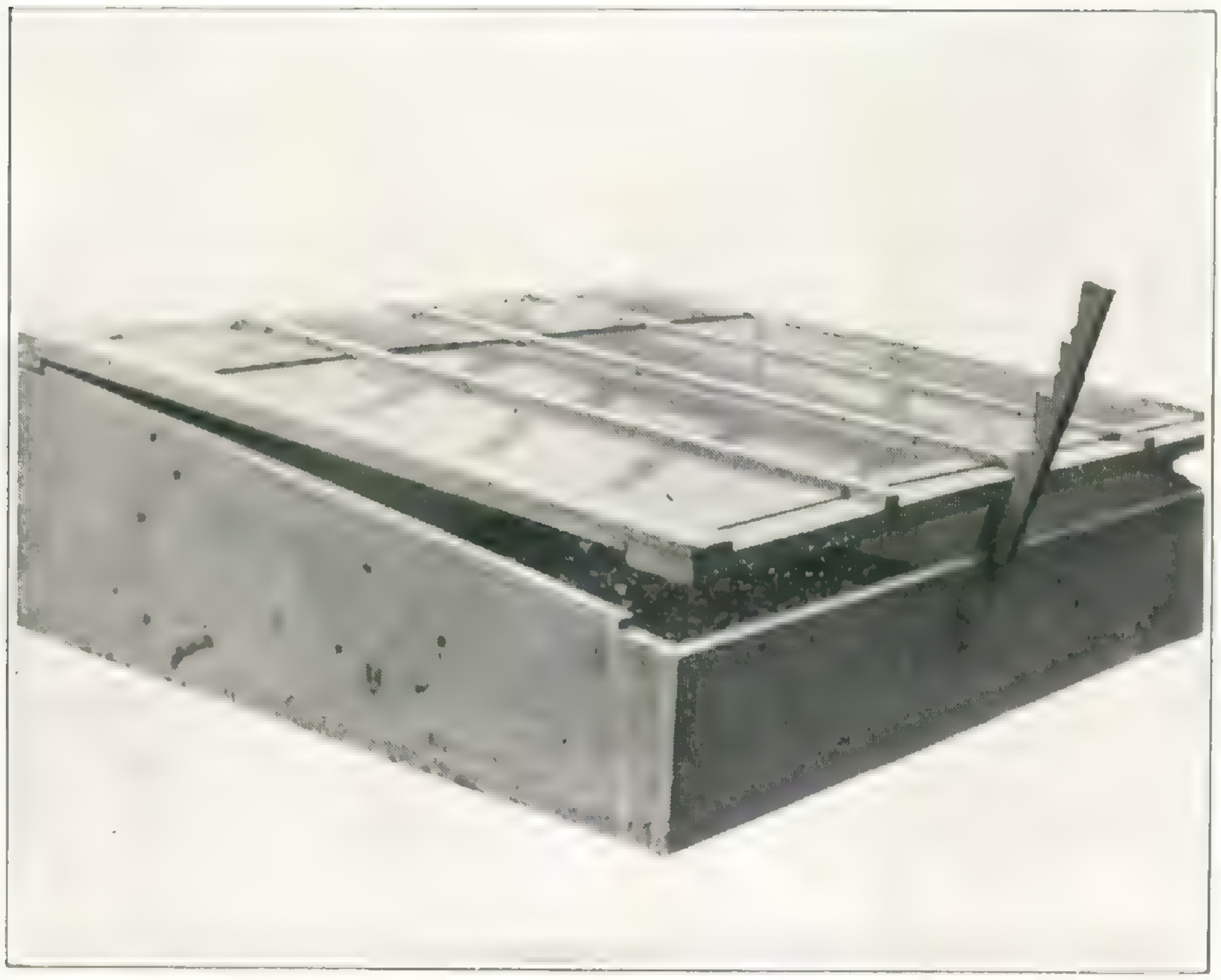


COLDFRAME

POTS, BOXES, AND COVER-GLASSES

Missouri Botanical Garden Bulletin

Vol. XXII SEPTEMBER, 1934 No. 7

GROWING PLANTS FROM SEED

The February, 1928, issue of the Garden BULLETIN was devoted to a detailed account of growing plants from seed. That this subject is one of the most interesting phases of plant culture is evidenced by the fact that the supply of this bulletin was soon exhausted and that the continuous demand makes a reprint necessary. The article has been widely copied by the various horticultural journals in this country; one western seedsman had it reprinted for his customers, and the most distant journal in which it has appeared was the "South African Gardening and Country Life." The step-by-step method of illustrating the article has been frequently used in the various horticultural magazines to illustrate other phases of gardening operations. While the main body of this reprint will remain substantially the same as the original, some changes have been necessary. The electric hotbed, with its thermostatic control, and the use of formaldehyde dust for controlling "damping-off" of seedlings are two important developments which have made their appearance only in the last three years.

The revised article follows:

With the beginning of the year the new seed catalogues make their appearance, and advertisements in magazines in-

vite those interested to send for copies. Upon turning the pages of the catalogues the imagination of the gardener is excited, and he sees in his mind's eye his beautiful garden the following summer. However, the gorgeous illustrations and the many glowing descriptions of plants often arouse higher expectations than he is able to achieve. So often he blames the seedsman for the poor quality of the seed when they fail to germinate, but the fault is really his in not knowing how to start the plants. It is true that old seeds sometimes find their way to various stores where they are kept from year to year, but if the seeds are bought from reliable firms or from racks where they are guaranteed to be fresh, failure to grow plants must be laid to ignorance of garden principles. The object of this article, with accompanying illustrations, is to help the home gardener with his problems in raising plants from seed.

The seedsmen's catalogues are improving every year, both in illustrations and descriptions. Some firms issue catalogues which contain much helpful information with each kind of plant listed; others have instructions printed on the seed packets, and still others include cultural leaflets with every shipment of seed. One small packet of a variety usually contains all the seeds necessary for the average garden if they are started indoors. If the seeds are sown directly outdoors allowance must be made for the many obstacles that often prevent the seedlings from getting a good start. Torrential rains frequently wash away seeds before they have had a chance to germinate. If the soil is very heavy or has been poorly prepared the seeds germinate, but the seedlings lack the strength to develop further.

Any one raising annuals or perennials from seed will find the beginning stage the most interesting. However, he must curb his enthusiasm and not start the plants too early in the season, or they will become stunted and crowded before it is time to plant them out. As there always is some danger of cold weather up to the early part of May, it is best not to start the quick-growing kinds until a month or six weeks before

time for planting outdoors. That means that most of the seeds should be sown toward the end of March and the beginning of April. Most perennials and those annuals that require a long period for their development may be sown in February. Such annuals are lobelia, pennisetum, petunia, salvia, snapdragon, verbena, and vinca. Another reason for delaying planting of the seed is the cold weather in February and March, and if the gardener is entirely dependent upon the coldframe for raising his plants he will lose some of them if started too early.

The manure-heated hotbed is a thing of the past and has been replaced by the electrically heated frame. Such a hotbed may be made by laying at least sixty feet of lead-covered cable in the bottom of the frame and covering with four to six inches of soil, the depth depending upon whether the plants are to be grown in pots or boxes or directly in the soil. The hotbed cable may be connected with any convenient electric-light socket in the home. Greenhouse builders can supply the materials and sketches for constructing these hotbeds, or information may be obtained from the local electric-light company.

After the latter part of March the weather is generally warm enough for growing seedlings in a coldframe. Figure 1, plate 43, shows a small frame which any one can build with little effort. It is not necessary to have a coldframe sash. Second-hand window sash can be obtained from house-wrecking companies for a few dollars, and the frame can be built to the size of the sash. If the seeds are sown in April a glass cover for the frame is not absolutely necessary. Oil-cloth, cheesecloth, cel-o-glass, or even boards can be used as a covering when protection is needed in colder weather. If seedlings are already growing in the coldframe and a sudden drop in temperature to the freezing point or lower is indicated, boards, old blankets, sacks, etc., may be used as an extra cover until warmer weather returns. However, a glass cover is an advantage, since sunlight can be admitted on cold days. Natu-

rally, the plants in the frame with the glass roof would benefit by the few extra days of light, while those in practically total darkness would suffer to a certain extent.

In placing the frames a position should be chosen that is sheltered on the west and north by a fence, building, or shrubbery. All frames should have a slope to carry off the rain, and this slope should be to the south. It is hardly necessary to state that they should receive sunlight the greater part of the day. If near-by buildings shade the garden during a part of the day, a position receiving the morning rather than afternoon light should be selected. When seeds are grown in the spring it is essential to secure as much sunlight as possible, but if they are sown in July and August the problem is to reduce the amount of sunlight. To accomplish this frames are placed with the slope to the north and shades made from plastering laths are placed over the frames.

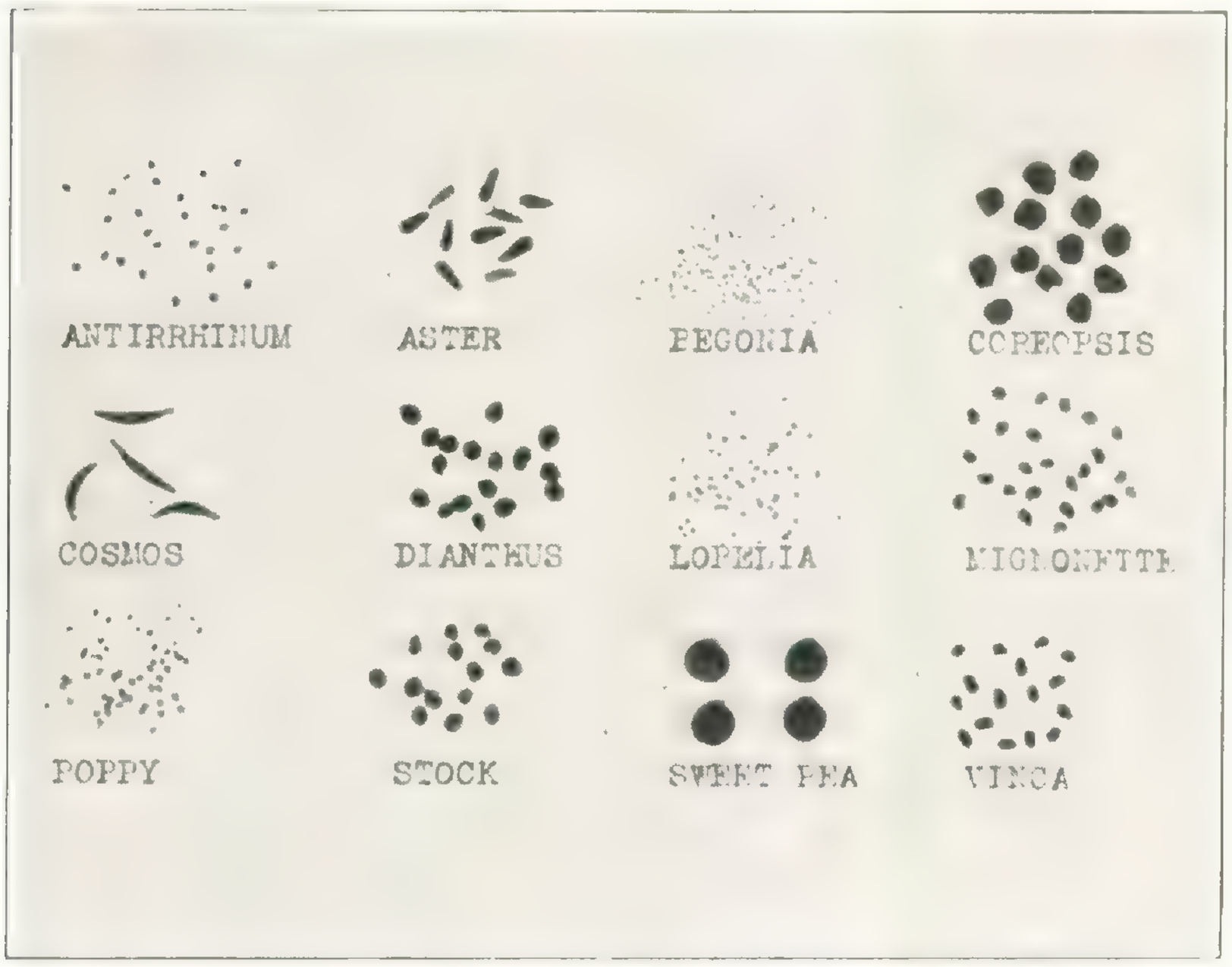
Sunlight is essential to the growth of plants. Seed may be sown in boxes or pots and set on any window sill. However, after the seedlings are up they must be placed in some window receiving sunlight. A southern window is best, but if this is not available one with an eastern or western exposure will do, the former being preferable. The temperature of the room should be between 60° and 70° F. When the sun shines through the window-pane the temperature mounts considerably, but this will be for only a few hours. A little fresh air during this time will greatly benefit the plants. After the seedlings are started they should be placed in a small frame outdoors if possible.

Pots, boxes, etc.—Tin cans, cigar boxes, discarded granite ware, pots, and special boxes termed flats may be used in which to start seed (fig. 2, pl. 43). Boxes may be made of various sizes, but if very large they are heavy to handle when filled with wet soil. Two convenient sizes are 12 x 15 x 3 inches and 15 x 20 x 3 inches. A depth of 3 inches is sufficient for the short time the plants are in the flats.

Drainage.—No matter what type of receptacle is used the

SCREENS, TAMPERS, DIBBER, AND LABELS

POTS OF SEED WATERED BY THE BUCKET AND THE CLOTH METHODS



TWELVE KINDS OF GARDEN SEEDS

DIFFERENCES IN GERMINATION OF SEEDS SOWN AT VARIOUS DEPTHS

bottom should have means to drain off the excess moisture. If the boxes are of wood several holes should be bored at the bottom or the boards should be spaced at least a quarter of an inch apart. If the boards of the flat are too close they will swell when moist and make the box water-tight. Any receptacle that does not permit the excess water to drain away will soon become water-logged. The soil then becomes sour and the plants die. Even though provision for drainage is made it is well to place some coarse material in the bottom of the receptacle to prevent the fine soil from clogging the holes or cracks. For this purpose broken pieces of flower pots (termed crocks), gravel, stones, and cinders may be used.

Flower pots come in various sizes according to diameter. A four-inch pot is about the smallest size that should be used for sowing seed. When only a very small quantity of seed is to be sown it is best to use a flower pot, the seed being broadcast over the surface. If many kinds of seeds are to be sown, most of which will germinate in about the same length of time, much space can be saved by sowing them in rows in boxes. Pots take up considerable space, while a small box can contain many rows of seedlings. Moreover, soil or sand in boxes will not dry out so rapidly as in pots.

Sieves, tampers, dibbers, labels.—Any one interested in growing plants from seed should secure some essential tools. They are all very simple and can be easily made. Sieves simplify the operation of sowing seed, especially fine seed, and once they are used they become a necessity. A fine screen need not be more than six or or eight inches square, but one with a coarser mesh for sieving large quantities of potting soil should be one by two feet or larger. The fine screen may be made by tacking a piece of window-screen wire cloth to a wooden frame. For coarser screens wire screening ⅛-, ¼-, or ½-inch mesh is used, the size of the mesh depending upon the nature of the soil and the purpose for which it is wanted. It would not only take a very long time to sift through a fine sieve all the soil necessary for some zinnias, but also it would

not be best for the plants. Finely sifted soil packs with repeated watering, thus excluding the air. The soil then becomes sour and the plants grown in it become stunted. The screen with the finest mesh is used only for small seed; for general use the sieve with a ¼-inch mesh is the proper size; for larger plants a coarser mesh should be used.

Figure 1, plate 44, shows two tampers, a square and a round one. The square one is easily made from a piece of one- or two-inch lumber, and may be about 3 x 6 inches or longer. An ordinary brick may serve for a tamper, but is too heavy to be used for any length of time. The round tamper is useful when sowing seed in pots, an empty flower pot answering the purpose. A dibber is a small stick about the size of a lead pencil. It is used when seedlings are transplanted. Wooden meat skewers make excellent dibbers.

The name of the plant and the date of sowing the seed should always be written on a label. In the summer the plants blooming at the same time might fit into some particular color scheme. This scheme could not be duplicated another season unless a record were kept of the time the plants were started. Moreover, many plants in the seedling stage look so much alike that confusion might result unless they were labeled.

Watering cans and methods of watering seed pots and boxes.—The average sprinkling can sold in the stores throws a rather coarse stream of water. Extremely fine seeds are barely pressed into the soil when sown and when watered with a heavy stream they are often washed away. Better types of cans may be purchased from seed stores and florists' supply houses. With a little care and patience seedlings may be started without the use of a watering can or with one of the poorer types. Figure 2, plate 44, shows two methods of watering seed. Setting the pot in a bucket of water and allowing the water to come up through the hole in the bottom until the surface of the soil becomes moist is an excellent way. With this method there is absolutely no danger of disturbing fine seeds as would be the case if watered from the top. After

the surface soil is moist the pot is removed from the bucket and the surplus water allowed to drain off. In order to prevent too rapid evaporation from the surface, the pot is sometimes covered with a piece of glass or paper until the seeds germinate. The sub-irrigation method need be practiced only a few times before the seeds are up. The pots must not be immersed so deep that the soil surface and the water level are of the same height, for the soil in the pot will then quickly become saturated. Soil that has been completely saturated shrinks from the side of the pot when dry and becomes a hard solid mass. Another way to prevent the seeds from being washed to the side of the pot or box when sprinkling with a can is shown in figure 2, plate 44. A piece of cloth is moistened and laid on the pot, and the sprinkling done through the cloth. The force of the water is broken by the cloth, and the moisture oozes through to the soil. After enough water has passed through the cloth should be removed.

Types and sizes of seeds.—Seeds vary a great deal in size, shape, and the length of time required for germination. Figure 1, plate 45, gives an idea of the sizes of some common flower seeds. It can easily be understood how difficult it is to raise some of these plants from seed when the essentials of germination are not understood. If the seeds of petunias and lobelias are covered with more than a quarter of an inch of soil failure to germinate may be expected, but if barely covered or lightly pressed into the soil more seedlings will come up than can be used. Seeds that are sown on the surface of the soil indoors or in a frame where practically all conditions of soil, moisture, light, and heat can be controlled will germinate readily, but if this were done in the open failure would result.

There is a certain relation between the depth that seeds are sown and their power to germinate. Seeds are frequently sown too deeply. Those covered with much soil do not get the proper amount of air and have the added burden of pushing up the layer of soil above them. Air (oxygen) is absolutely necessary for the germination of seeds. Sow seeds

the proper way and watch them germinate, but place some of them in water, which contains very little air, and they will rot. Figure 2, plate 45, shows very clearly what happens to seeds sown at various depths. Those near the surface were the first to germinate and grow, and while some of the others lower down have germinated, the odds against them are too great and they will finally succumb. Some of the seeds planted deep have already rotted.

When sowing seeds the extremely small ones should be pressed into the soil after it has been watered, or the sub-irrigation method used. All small seeds should barely be covered, just enough fine soil or sand being passed through the sieve to conceal them. In sieving soil or sand over small seeds the sieve should be held not more than an inch or two above the surface of the soil. If held higher, the particles of sand or soil striking the seeds will cause them to jump in all directions, with the result that some of them will immediately be covered and the remainder will still be on the surface, or some will have a light covering and others a heavy one. This will result in uneven and many times poor germination. In sowing fine seed the tendency is to make the soil too fine. The finer the particles, the more compact the mass of soil will become, and after wetting such soil will bind and become hard. When fine seeds are sown upon such a surface their delicate roots experience great difficulty in penetrating the hard surface. They generally remain stunted at the surface and finally succumb. Fine seeds sown upon a rough surface are more apt to grow. Larger seeds, such as coreopsis, hollyhocks, asters, and cornflowers, may be sown somewhat more deeply, being covered with about an eighth of an inch of soil.

Soil medium in which to sow seeds.—Most seeds have been and probably always will be sown in soil. It is the commonest material available and gives good results. The best soil for the purpose is composed of about one part loam, one part leaf-mold, and one part sand. By loam is meant a soil that

SEED-SOWING OPERATIONS

TOMATO SEED SOWN IN SAND AND SOIL, SHOWING MUCH BETTER AND QUICKER GERMINATION IN SAND

SPROUTING SEEDLINGS

contains a liberal amount of vegetable matter in the form of decaying roots, leaves, etc.

Sand is the most convenient material in which seed may be sown. However, if sand is used the seeds require much closer watching. After a seedling has germinated and the roots are formed they begin searching for food. Sand is practically devoid of any food material. Consequently as soon as the seedlings have germinated and are large enough for handling they should be transplanted to pots or boxes containing soil. If left in pure sand for a length of time they will remain alive, but will be stunted. Sand dries out rapidly, and if not kept constantly moist the seedlings will be lost at the critical time of germination. Seedlings that have germinated and whose roots extend down about an inch will not suffer if the surface sand becomes dry. However, extremely fine seeds that are very near the surface might just be germinating when the surface dries out, and if the sun is shining the seedlings will be lost in a short time. Aside from the two main objections—lack of food and the rapidity with which it dries out—sand has so many good qualities that it cannot be overlooked as a material in which to sow seed.

An excellent method is to prepare the box or pot of soil, place about an eighth of an inch layer of sand on top, firm, sow the seed, and cover with sand. Such seed must be carefully watched until germination takes place. When the seedlings are growing, however, their roots will have passed from the sand to the soil below and will grow in the same way as if sown directly on soil.

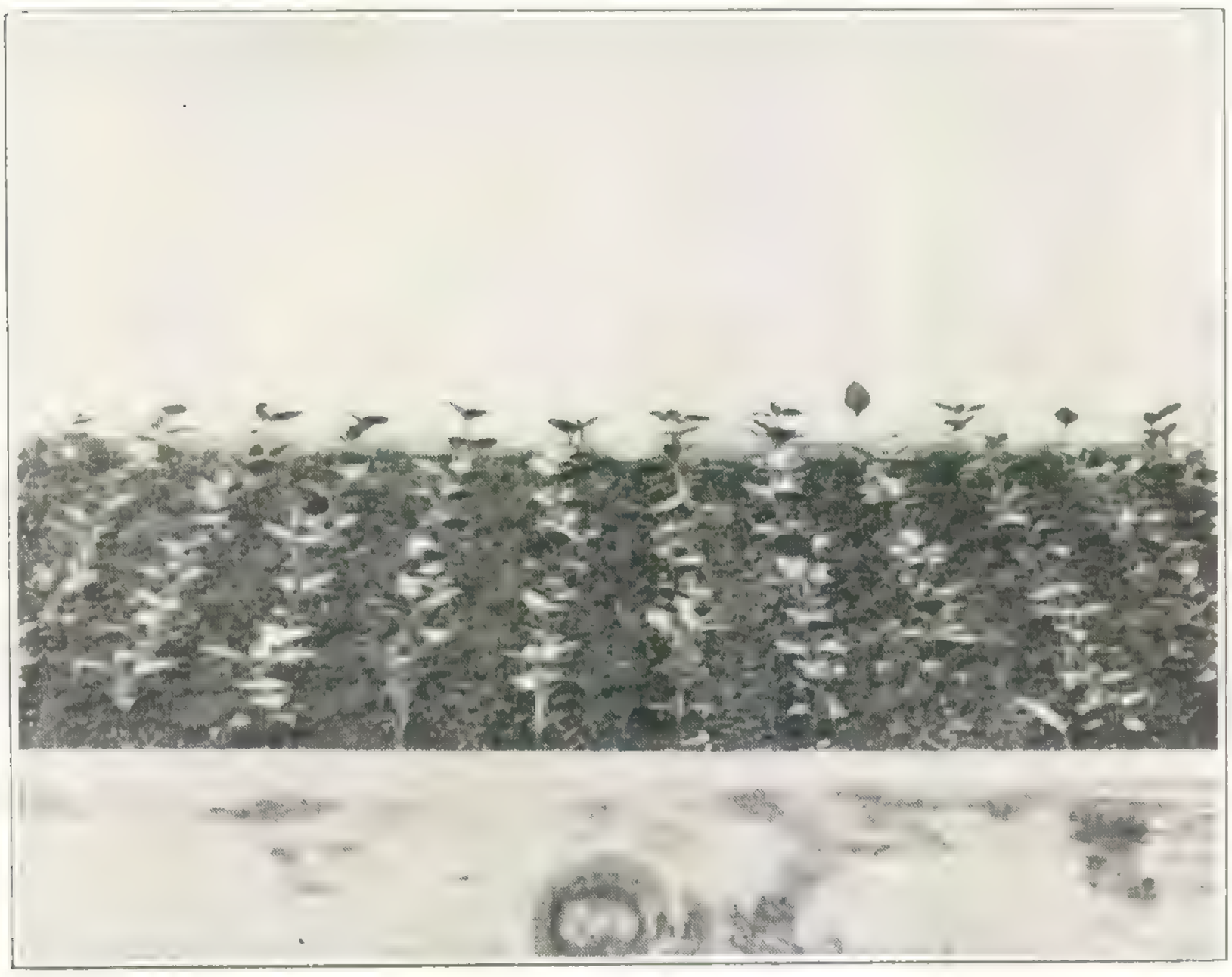
Seedlings are always subject to the ravages of the damping-off disease. The thread-like parasite spreads over the surface of the soil and may destroy a crop of seedlings over night. This disease is always associated with a great amount of humidity, and on that account seedlings just germinating should never be watered toward evening. If seeds are sown in sand instead of soil there is much less danger from attacks of the

damping-off disease. One of the chief reasons why sand is so much better than soil for sowing seed is that it does not retain as much moisture, even though it is watered more frequently. Seedlings will be lost by the damping-off disease, even if seeds are sown in sand, if they are crowded or if the air about the seedlings is very humid. This humid condition can easily be created if the cover-glass or paper is left on the boxes or pots after the seedlings are up. Various precautions should be taken to prevent the spread of damping-off disease. Clean receptacles should always be used; pots should be washed and boxes brushed. Undoubtedly steam sterilization will help to prevent damping-off, but practically no amateur is equipped to use that method. Heating the soil in an oven will kill many disease spores, or pouring boiling water over the surface before sowing the seed will help. If boiling water is used the soil must be left to dry for a day or two, because working wet soil will cause it to puddle, much to the detriment of the seed sown. Semesan is still used in treating seeds before sowing, and in the last few years formaldehyde dust, worked into the surface soil before sowing seeds, has proved very beneficial in controlling damping-off. None of these methods or materials will prevent damping-off if the other essentials of careful watering, ventilation, or the admission of light are disregarded.

Seedlings germinate more uniformly in sand than in soil, and have less difficulty in pushing up. Those sown in soil and covered with a layer of soil, or those planted close together often push up a whole crust of soil, much to their detriment. Seedlings are much more easily separated for transplanting when grown in sand than in soil. Because sand drains so readily it always warms up more rapidly and this hastens germination. The better germination in sand is well illustrated by the tomato seedlings shown in figure 1, plate 47. One pot contained pure sand, the other soil, and the two pots were treated alike in all respects. If the sand is dirty, it should be washed. To do this a bucket is filled about half full

TRANSPLANTING OPERATIONS

CULTIVATING SEEDLINGS



SEEDLING SNAPDRAGONS READY FOR POTTING

of sand and water run in through a hose. The dirt, being lighter than sand, will float and will be carried over the top of the bucket. Moving the hose about will rapidly free the dirt, and when the water is clear the sand is clean.

Sowing the seed.—Plate 46 shows the essential operations in the sowing of seed in boxes, and with few exceptions the same methods hold for pots or any other receptacle. As previously mentioned the box should have holes or cracks in the bottom. The first step is to cover these openings with broken crocks, stones, etc. The box should then be filled to overflowing with sand or soil, leveled with a stick, and tamped lightly. The surface of the soil will then be about 3/8 of an inch below the top edge of the box. If the soil or sand is an inch below the top of the box much trouble may be anticipated with the damping-off disease due to the poorer air circulation. After the soil is tamped, the rows are marked with a stick or plant label, the stick being pressed into the surface to the depth wanted for the seed. For fine seeds the surface is barely marked, for large seed a deeper trench is required. Before making the rows the soil or sand must be moist, for if dry it immediately rolls back in the trench when the stick is withdrawn. After the rows are made the seed is ready for sowing, and for convenience one corner of the seed packet is torn off and the packet lightly tapped to secure an even distribution of the seed along the rows. It is best to allow one row for each kind of seed, or at least one-half row for a kind. In this way the label can be placed either at the beginning or at the end of the row. If labels are placed in the rows they will interfere with the glass or paper cover.

A mouse can do much damage in a pot or flat of seed in one night, so the pot or box should be covered with a sheet of glass or a board. After the seeds have germinated and are growing there is seldom any danger from mice. While on the subject of losing seed by other means than the damping-off disease it might be well to warn against the cunning antics of ants. Ants will carry away any seed that is not too large for

them to handle. They prefer seeds just as they are germinating, but will also carry away newly sown seed. As they are wont to lick anything, be it insect or seed, that exudes a sweet substance, they supposedly carry the seed to their nests. They will sometimes appear when least expected. If they are in the neighborhood of a box of seed it is well to place a water barrier between them and the seed box. Placing the boxes on inverted flower pots set in one or more saucers of water will prevent the ants from causing any trouble. If only a pot of seed is to be protected it may be stood on a half brick in a saucer or pan of water. If many pots or boxes are used they may be set on a platform supported by standing four bricks in water.

After all the seeds are sown sand is sieved over the rows. Some sand should have been set aside to dry, so that it would run through the sieve easily. The deeper rows containing the large seeds should receive a heavier covering than the small ones in the shallow rows. After the seeds are all covered the flat is watered and then a pane of glass or a piece of paper or both are placed over the box. Moisture will accumulate on the glass and should be removed each morning. If the glass is carefully removed from the pot and held by one corner, the water will run off quickly. If the glass is carelessly removed the large drops of water will splash fine seeds in all directions. When the seeds begin germinating the glass or paper should be raised slightly at one side to admit air, and after the seedlings begin pushing through, the box should be uncovered. A great many seedlings will be lost if the cover is left on too long. The close atmosphere under the cover is ideal for the spread of fungous growths.

Eight operations in transplanting seedlings.—After the seedlings are up and are sufficiently large to handle they are ready for transplanting. Removing seedlings from their boxes should not be postponed too long. While seeds should not be sown thickly they are always more or less crowded in the boxes or pots and should be separated from their neighbors

as soon as possible. Plate 48 illustrates the various operations in transplanting seedlings. The majority of seedling plants are sufficiently large to be handled with the fingers. They either have a leaf large enough to act as a handle or are strong enough to be held by the stem. Whenever possible a seedling should be held by a leaf, as then there is less danger of crushing the tender plant. Some seedlings, notably petunias, lobelias, begonias, etc., are so very small that it is impossible to handle them with the fingers. The last three figures of plate 48 show how minute seedlings are handled.

The box into which the seedlings are to be transplanted should contain some drainage material and should be filled up with a light soil. The box must be leveled and tamped in the same manner as when the seeds were sown. The surface should be finished with some finely sifted soil and tamped. If this is not done, especially when small seedlings are to be transplanted, the small lumps of soil will cause much annoyance. If the soil is very dry it should be watered before transplanting the seedlings and then set aside. A box of soil that is damp and needs no water is to be preferred to one that has been watered an hour previous. Soggy soil clings to the dibber and the fingers.

To remove the seedlings from the seed box, with the right hand insert a stick or plant label beneath the roots and gently raise a bunch of seedlings, at the same time grasping them with the left hand. Do not take all of the seedlings from the box at one time as they dry out very rapidly. Lay them on a piece of paper and bring them to the box of soil. Mark the rows on the surface of the soil with a straight-edged stick. Space the rows in the flat from one and a half to two or three inches apart, depending upon the size of the plants. Also space the plants the same distance in the rows. The size of the seedlings soon after germinating serves as a fair indication of the distance apart to transplant them. With the dibber make a hole in the soil deep enough to receive the roots without crowding. Slightly turn the dibber back and

forth as it is withdrawn from the hole to prevent any soil from rolling back. If the seedlings have unusually long taproots, pinch them back halfway. This will do no harm and will cause the plantlet to send out lateral roots. After the seedling is placed in the hole the dibber is again thrust into the soil near the seedling and the soil firmly pushed against the roots. If an air pocket is left at the bottom of the hole the roots cannot come in contact with the soil. Seedlings should be transplanted to about the same depth as they were in the seed box. However, when seedlings are very spindly and have a tendency to shoot up, they should be planted deeper in the hole. There are some kinds of seedlings, the delphinium being an example, in which the heart of the plant is quite low. In transplanting such seedlings one must be careful not to cover the center of the plant, lest it might rot. Again there are large seedlings that produce robust plants (lupines, castor beans, etc.). These should be immediately set into two- or two and one-half-inch pots.

In order that minute seedlings may safely be transferred to flats of soil a small wooden fork made from a plant label or any piece of thin wood is used. With this fork the seedling is lifted and if it clings to some of the others they are separated with the dibber. The dibber for transplanting tiny seedlings should have more of a point than the ordinary dibber. A collection of dibbers of various thicknesses for different sizes of seedlings will prove most convenient. Holding the wooden fork with the left hand, lift the seedling to the seed box, barely make a depression in the soil, then lower the seedling and firm a little soil around it with the dibber. Tiny seedlings must be carefully watered until they produce enough roots to hold them in place. A watering pot with a fine-spray nozzle is essential to such work. If very small seedlings are set in a flower pot they can be watered by the sub-irrigation bucket method. After the flat is filled with plants it should be watered and placed in the frame or window. If the sun is shining brightly, shade the plants with paper the first and

second days. Seedlings that have been crushed or broken in handling will wilt and die.

If the seedlings are transplanted to a pot instead of a box, and this can be done if only a few dozen of a kind are wanted, the surface of the soil should not be more than one-fourth inch below the top of the pot. Larger seedlings may be set deeper. Seedlings planted in flats will not dry out as rapidly as those in pots, and more can be grown in a given space if planted in rows in flats than if grown in pots. After a length of time the soil in the flats becomes packed by repeated watering. Weed seeds will also have germinated and will begin to crowd the seedlings. Cultivating the flats (fig. 1, pl. 49) will discourage the weeds and will benefit the plants. Seedlings that grow too rapidly and show no signs of branching should be pinched when they become two and three inches high. When the seedlings become crowded they should be transplanted to pots (fig. 2, pl. 49). If it is intended to leave the seedlings in the flats until time for planting directly into the garden, more space should be allowed in the flats when they are transplanted from the seed-box.

Seedlings that are to be transplanted to pots should be carefully lifted with a spoon or plant label and should have as much soil adhering to the roots as possible. The plant is held in the center of the pot. Then the soil is added and firmed about the seedling. Just when to water the seedlings after repotting will depend upon weather and soil conditions. If the day is cloudy and the potting soil is moist a day may elapse before watering. If, however, the soil is dry, but this condition could be improved when the soil is mixed, and the day clear and warm, the seedlings will have to be watered soon after potting. The pots should be soaked before using if very dry, otherwise they will absorb much of the soil moisture. When a plant is reset the root system is disturbed and if the potting soil is moderately moist new roots will form more quickly than if the soil is quite wet. It is always a good policy to keep newly potted plants a little on the "dry side"

until root development is again active. Wilting may be prevented during this period by lightly spraying the foliage and shading the plants.

When warm weather has arrived and the flower beds are prepared the plants may be taken out of the pots and set in their place. Plants whose roots have become matted due to the length of time in the pots should have the bottom roots loosened before planting. This will break up the distinct ball the roots have been forming and will cause them to strike out in all directions and take hold of the soil in the flower bed. Plants that have been planted in beds should receive a good watering as soon as possible after all are set. The same precautions used when transplanting from boxes to pots must be taken against wilting when planting the seedlings in the flower beds. Cloudy weather is ideal for planting flowers outside. Late afternoon and evening are better than the morning for transplanting, as the plants can revive during the night. Transplanting should not be done on extremely hot and windy days. A good gardener will find ways and means to overcome the difficulties that will at times confront him.

P. A. K.

NOTES

Mr. George H. Pring, Superintendent of the Garden, has been reelected president of the St. Louis Florists' Club for the ensuing year.

Mr. Pring, gave a talk over Radio Station KSD, September 9, on "The Effect of Drouth and Heat on Plants."

Mr. Pring acted as one of the judges of the city and county gardens for the Horticultural Society Contest, also for the Community Gardens.

Dr. David C. Fairburn, Research Assistant to the Garden, acted as judge of the section of floriculture at the Missouri State Fair, Sedalia, August 13-14.

Professor B. S. Pickett, professor of horticulture, Iowa

State College, Ames, Ia., accompanied by a group of his students in horticulture, visited the Garden and Arboretum, July 13-14.

Mr. L. P. Jensen, Arboriculturist to the Garden, has been re-elected president of the Garden Club of Gray Summit, Missouri, also of the Watson-Antire Regionway Improvement Association.

On August 25, a wreath of magnolia leaves and white lilies was placed on the tomb of Henry Shaw in the mausoleum grove at the Garden, in commemoration of the forty-fifth anniversary of his death.

The "Meramec Valley Transcript," Pacific, Mo., reprinted Mr. Jensen's paper given at the convention of the American Institute of Park Executives at Toronto, Canada, on "Arboricultural Development in the Missouri Botanical Garden Arboretum."

Dr. E. Percy Phillips, principal botanist, division of plant industry, Pretoria, South Africa, arrived at the Garden on July 30. He spent several days studying the collections in the herbarium and in the greenhouses of the city Garden, and also visited the Arboretum at Gray Summit.

Among those visiting the Garden library and herbarium during the summer were Dr. Thomas I. Edwards and Dr. Ralph G. Schott, of Johns Hopkins University, Baltimore, Md.; Dr. P. A. van der Bijl, professor of mycology, University of Stellenbosch, South Africa; Dr. M. A. Chrysler, professor of botany, Rutgers University, New Brunswick, N. J.; Dr. M. L. Lohman, division of forest pathology, U. S. Department of Agriculture, Asheville, N. C.; Dr. Carl G. Deuber, assistant professor of plant physiology, Yale University, New Haven, Conn.; Dr. John Wishart, of Clare College, University of Cambridge, England; Dr. Lake S. Gill, associate pathologist, division of forest pathology, U. S. Department of Agriculture, San Francisco; Dr. J. B. S. Norton, professor of systematic botany and mycology, University of Maryland, College Park, Md.

The death of Mr. Clarence T. Pedlow at Rockford, Ill., on July 23, is regretfully announced. Mr. Pedlow graduated from the Missouri Botanical Garden School for Gardening in 1917. In 1920 he was appointed City Forester and Park Engineer of the Rockford Park Department, and in 1927 he became Superintendent of the Rockford Park District. Mr. Pedlow visited the Garden in early June.

Mr. L. P. Jensen, Arboriculturist to the Garden, spoke before the members of the Citizens' Road Association, at the Missouri State Highway Department Building, Jefferson City, June 12, on "Roadside Improvement"; and at the dedication of the planting at the Franklin County courthouse, at Union, Mo., on "The Value and Importance of the Planting of Public Grounds."

On May 30, at a meeting of the Watson-Antire Regionway Improvement Association, at Eureka, Mo., the roadside planting on Highway 66 was dedicated. From the city limits to the Missouri Botanical Garden Arboretum, at Gray Summit, Mo., a distance of thirty-five miles, more than ten thousand trees and shrubs have been planted under the auspices of this association. Mr. L. P. Jensen, President of the Association, presided, and Dr. George T. Moore, Director of the Garden, spoke on the cooperation of the Garden in this development. At this meeting it was suggested that the beautified highway be named the "Henry Shaw Garden Way."

In commemoration of the birthday of Henry Shaw, July 24, 1800, a bronze tablet enclosing a painting of the former city home of Henry Shaw was unveiled and dedicated on Sunday afternoon, July 22. This tablet is placed on the Seventh Street side of the Franklin-American Trust Building, at Seventh and Locust Streets, the former site of the house illustrated in the picture. It is one of many markers being placed by the Historic Sites Committee of the Young Men's Division of the St. Louis Chamber of Commerce. By direction of Mr. Shaw's will, the house was removed in 1890 from this location to the Garden, his country home, and is now used as

the administration building of the Garden. Dr. George T. Moore, Director of the Garden, took part in the dedication ceremonies, as did also John C. Feugh, the one remaining employee of the Garden who was at one time employed by Henry Shaw.

STATISTICAL INFORMATION FOR JUNE-AUGUST, 1934

GARDEN ATTENDANCE:

Total number of visitors in June	21,134
Total number of visitors in July	21,144
Total number of visitors in August	25,941

PLANT ACCESSIONS:

Total number of plants and packets of seeds donated in June	596
Total number of plants and packets of seeds donated in July	159
Total number of packets of seeds donated in August	51

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought in June	81
Total number of books and pamphlets donated in June	230
Total number of books and pamphlets bought in July	26
Total number of books and pamphlets donated in July	173
Total number of books and pamphlets bought in August	8
Total number of books and pamphlets donated in August	99

HERBARIUM ACCESSIONS:

JUNE

By Purchase—	
Gleason, H. A.—Plants of Brazil collected by B. A. Krukoff	1,000
Harper, R. M.—Plants of Alabama	121
Verdoorn, Fr.—"Musci selecti et critici," Series I, Nos. 1-50 inclusive, 1934	50
By Gift—	
Berkley, E. E.—Pines of Southern United States	5
Ewan, J. A.—*Grindelia* sp. from California	1
Featherly, H. I.—*Drosera annua* Reed from Oklahoma	1
von Holdt, F.—*Dodecatheon pauciflorum* (Durand) Greene from Montana	1
Woodson, R. E., Jr.—Specimens and photographs of *Tradescantia*	25
By Exchange—	
New York Botanical Garden—Plants of California	43

Tharp, B. C.—Plants of Texas	161
U. S. National Museum—Lichens of South America	88
University of California—Plants of western United States	220
Total	1,716

JULY

By Purchase—	
Bush, B. F.—Plants of Missouri	396
Weigel, Theo. Oswald—Carl Junge, "Plantae chilensis," Cent. II, Fasc. 1 and 2, Nos. 1-150	50
By Gift—	
Bramsch, Helen—*Marchantia polymorpha* L. from Wyoming	1
Harrison, Bertrand—Plants of Utah	400
Holtzmann, Mrs. I. E.—*Vicia Cracca* L. from Missouri	1
Howe, M. A.—*Senecio salignus* DC. from Mexico	1
Woodson, R. E. Jr.—Fragment of *Poacynum pictum* (Schrenk) Baill.	1
By Exchange—	
Gray Herbarium, Harvard University—Plants of Greenland, Brazil, etc.	87
Philadelphia Academy of Natural Sciences by F. W. Pennell—Scrophulariaceae from eastern United States	413
University of Michigan—*Tradescantia micrantha* Torr. from Texas	1
Total	1,351

AUGUST

By Purchase—	
Bush, B. F.—Plants of Missouri	70
Collom, Mrs. Rose E.—Plants of Arizona	218
Degener, Otto—Plants of the Hawaiian Islands	85
By Gift—	
Lahman, Mrs. C. E.—*Kneiffia* sp. from Oklahoma	1
Peirson, Frank W.—Plants of California	3
Pottz, Glenn E.—*Trianthema Portulacastrum* L. from Oklahoma	1
Shannon, E. L.—*Leptodictyon riparium* (Hedw.) Warnst. forma *flaccidum* from Oklahoma	1
Stemen, T. R. and W. Stanley Meyers—Plants of Oklahoma	2
Woodson, R. E., Jr.—Plants of British Honduras	4
Woodson, R. E., Jr.—Fragments and photographs of Apocynaceae	2
Total	387

SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date to the death of Mr. Shaw, in 1889, the Garden was maintained under the personal direction of its founder, and while virtually a private garden it was, except at certain stated times, always open to the public. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was designated by Mr. Shaw as its official title and in his will or in any of his writings he specifically referred to it as the "Missouri Botanical Garden." By a provision of Mr. Shaw's will the Garden passed at his death into the hands of a Board of Trustees. The original members of the Board were designated in the will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will, the immediate direction of the Garden is vested in a Director, appointed by the Board of Trustees. The Garden receives no income from city or state, but is supported entirely from funds left by the founder.

The city Garden comprises 75 acres, where about 12,000 species of plants are growing. There is now in process of development a tract of land of over 1,500 acres outside the city limits which is to be devoted to (1) the propagation and growing of plants, trees, and shrubs, designed for showing either indoors or outside, at the city Garden, thus avoiding the existing difficulties of growing plants in the city atmosphere; (2) gradually establishing an arboretum as well as holding a certain area as a forest reservation, with the idea that possibly at some future time this may become the new botanical garden.

The Garden is open to the public every day in the year, except New Year's Day and Christmas—week days from 8:00 a. m. until one-half hour after sunset; Sundays from 10 a. m. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Place, on the Sarah car line (No. 42). Transfer south from all intersecting lines. The Garden may also be reached by Bus Route No. 12, to which all other motor-bus lines transfer.

STAFF
OF THE MISSOURI BOTANICAL GARDEN

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MISSOURI BOTANICAL GARDEN BULLETIN

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SHORT-CUPPED DAFFODILS OR NARCISSUS

Missouri Botanical Garden Bulletin

Vol. XXII OCTOBER, 1934 No. 8

SOME NEW AND NOTEWORTHY NARCISSUS

Each group of garden flowers has its period of popularity, only to be replaced later by some new arrival, new, not in the sense that the plant has never been grown before, but new because better varieties have been developed as the result of the plant-breeder's art. In the last few years the pendulum of popularity has swung to the daffodil. After the plant quarantine went into effect some years ago there was a lull in the culture of this flower. American growers were not able to supply bulbs similar to those formerly imported and the prices were prohibitive. Now, however, new and better varieties are being offered, many of them at reasonable prices.

The following list gives the names of varieties of Narcissus which have been grown at the Garden for the past two years; a brief description; the date of bloom, which is practically the same every year; and notes on the increase of the bulbs. While the price of some of these varieties is still high as compared with other bulbs, the money spent for daffodils is an investment that pays dividends year after year in the increased number of bulbs and flowers. Most of the varieties mentioned are listed by some of the leading bulb dealers in this country. The dates that the varieties are at their best in this locality are accurate. Since these bulbs had to be taken up and replanted, it was possible to determine how rapidly the varieties increased

in two years. The notation, "good," "fair," or "poor," after each variety indicates the amount of increase, and can be regarded as a safe index to their ability to produce additional bulbs. However, allowance should be made for a change in location which might influence the rate of increase of some varieties.

YELLOW-TRUMPET DAFFODILS

VARIETIES WITH YELLOW OR LEMON-COLORED TRUMPETS, AND SAME SHADE OR LIGHTER PERIANTH (BUT NOT WHITE)

Alasnam.—Good, erect daffodil, one of the first to bloom. Trumpet pure deep yellow, frilled; perianth a shade lighter. April 3. Good increase.

Arcolite.—One of the earliest and longest-lasting trumpet daffodils. Flowers large, well proportioned, and graceful; perianth primrose; trumpet medium-yellow. April 5. Good increase.

King Arthur.—Similar to King Alfred, with a large trumpet. April 17. Fair increase.

Maryland.—Yellow perianth and golden-yellow trumpet. April 15. Fair increase.

Matamax.—Also similar to King Alfred, of which it is a seedling. April 15. Fair increase.

WHITE-TRUMPET DAFFODILS

VARIETIES WITH WHITE TRUMPET AND PERIANTH

Eve.—Flowers of good size and well proportioned; trumpet a very pale yellow. April 12. Fair increase.

La Vestale.—A very good variety. Trumpet large, deep cream-yellow; perianth ivory-white. April 6. Good increase.

Lovenest.—A very dainty variety, medium height. Trumpet saffron-yellow, turning to apricot-pink. April 9. Good increase.

BI-COLOR VARIETIES

VARIETIES WITH YELLOW, LEMON, OR PRIMROSE TRUMPET, AND A WHITE OR WHITISH PERIANTH

Sylvanite.—A good new variety and a strong grower. Perianth creamy white; trumpet light canary-yellow. April 12. Good increase.

INCOMPARABILIS NARCISSI

CUP OR CROWN NOT LESS THAN ONE-THIRD, BUT LESS THAN EQUAL, THE LENGTH OF THE PERIANTH SEGMENTS

Donatello.—Perianth light primrose-yellow; trumpet a pure deep yellow, ruffled and frilled. April 15. Poor increase.

Gallipoli.—Perianth citron-yellow; cup yellow, deeply fluted to base; flowers droop slightly. April 15. Good increase.

John Evelyn.—Perianth pure white; cup lemon-yellow and fluted; flower large. April 12. Fair increase.

Mi-Careme.—One of the best; increases rapidly and has a long blooming season. April 5. Good increase.

Stella Pratt.—Star-shaped perianth of light primrose-yellow; trumpet a deep yellow. April 15. Good increase.

Tampa.—Flowers large; perianth cream-white; cup yellow, heavily frilled. April 18. Good increase.

BARRII

CUP OR CROWN LESS THAN ONE-THIRD THE LENGTH OF THE PERIANTH SEGMENTS

Alcibiades.—Tall and late. White perianth; cup yellow with red-orange frill. April 25. Good increase.

Alcida.—One of the best; blooms late. Large flower; pure white perianth opening flat; cup citron-yellow with red-orange frill. April 20. Good increase.

Arthur Bowman.—A very good variety. Perianth pure white; flat cup, lemon-yellow, edged with red. April 17. Fair increase.

Bohemienne.—Perianth flat; cup light yellow with orange picotee. April 22. Fair increase.

Diana Kasner.—One of the best. Perianth white; cup large, fluted, yellow with red frill. April 20. Good increase.

Dosoris.—Perianth white, cup flat, frilled, edged with red-orange. April 20. Fair increase.

Firetail.—A good and very popular variety. Perianth cream-white; cup large, orange with scarlet-orange frill. April 15. Fair increase.

Frau Margaret Hohmann.—Perianth cream-white; flaring lemon-yellow cup with orange margin and red edge. April 25. Fair increase.

Mrs. Barclay.—Very good large flowers; perianth pale primrose changing to white; cup frilled, flat, primrose-yellow; orange picotee. April 15. Fair increase.

Muriel.—Perianth pure white; cup with brilliant red edge. April 15. Fair increase.

Nursemaid.—Broad, overlapping petals; cup orange, edged with scarlet. April 15. Good increase.

Sunrise.—White, star-shaped perianth; cup small, yellow-orange, scarlet margin. April 15. Good increase.

LEEDSII

PERIANTH WHITE, CUP OR CROWN WHITE, CREAM, OR PALE CITRON, SOMETIMES TINGED WITH PINK OR APRICOT

Arion.—Perianth cream-white, broad-petaled; cup sulphur-yellow, edged with orange. April 15. Good increase.

Gainsborough.—Tall. Perianth broad-petaled; cup light yellow, orange picotee around crinkled edge. April 24. Good increase.

Mrs. Nettie O'Melveny.—A very good variety. Perianth pure white; cup clear lemon-yellow with orange picotee. April 12. Good increase.

Silver Star.—Cream-white, star-shaped perianth; wide-mouthed primrose trumpet which turns white. April 7. No increase.

TRIANDRUS HYBRIDS

CYCLAMEN-FLOWERED DAFFODILS WITH REFLEXING PERIANTH. FLOWERS MORE OR LESS DROOPING, OF ELEGANT FORM AND GRACEFUL HABIT

Moonshine.—A good, dwarf, cream-white flower, often three to a stem. April 20. Good increase.

Mrs. Alfred Pearson.—Perianth white; cup pale primrose. Failed to bloom in 1934. April 20. Fair increase.

Pearly Queen.—Two to three flowers to the stem. Perianth cream-white; trumpet clear lemon-yellow. April 17. Good increase.

JONQUILLA HYBRIDS

ALL VARIETIES OF *N. JONQUILLA* PARENTAGE

Buttercup.—Buttercup-yellow flowers borne on long stems. April 17. Good increase.

Golden Sceptre.—Deep yellow, star-shaped perianth a little paler than the trumpet. April 15. Good increase.

Tullus Hostilius.—Good, strong grower. Jonquil-yellow trumpet type. April 17. Good increase.

DOUBLE NARCISSI

Snowsprite.—Flowers white with light lemon shadings. No bloom in 1934. April 27. Poor increase.

Twink.—A double, soft primrose and clear orange coloring. Buds blasted in 1934. April 10. Fair increase.

P. A. K.

THE WAX-PLANT

Some of the most curious, as well as beautiful, plants are to be found among the Asclepiads, or milkweeds. In the 1933 volume of the BULLETIN appear descriptions and illustrations of two representatives of the family: "Ceropegias" (June, 1933), and Stapelia ("Carrion Flowers," November, 1933).

The milkweeds are extremely variable, and it is hard to realize that the non-succulent climbing Vincetoxicum, with heart-shaped leaves, Stapelia, with short, fleshy, four-angled leafless stems, and the twining, succulent-leaved Hoya, are closely related. Nevertheless, they are all members of the Asclepiadaceae, or milkweed, family, and possess the structure of fruit and seed characteristic of that group. All produce follicular

TRUMPET DAFFODILS OR NARCISSUS

FOLLICLES OF STAPELIA EMITTING SEED

HOYA CARNOSA IN BLOOM

pods which burst and set free the seeds. The seeds, with their tufts of silky hairs, are blown about by the wind and disseminate the plants far and wide (pl. 52, fig. 1).

One of the most interesting plants of this family is *Hoya carnosa,* or climbing wax-plant. The genus is named in honor of Thomas Hoy, once gardener to the Duke of Northumberland. It is a native of tropical Asia and Australia, and has been in cultivation in this country for over a hundred years. The plant is desirable at all times, but is especially showy when in flower. In well-established specimens hundreds of flowers bloom continuously during the summer, from May until August, and nothing could be more beautiful than the delicate pinkish, waxy flowers against the background of dark green shiny leaves (pl. 52, fig. 2). The flowers, usually nearly an inch in diameter, are borne in pendulous umbels on short peduncles. The purplish-red pedicels and sepals are soft-pubescent, and the fleshy corolla is bearded on the inside. The crown segments, in the form of a star, are glistening white tinged with purple-red in the center. The leaves are dark green, ovate-oblong, with tapering tips, fleshy and leathery in texture, like those of the pepper-elders (Peperomia). A form of this species has variegated or splotched leaves. The flowers exude drops of sweet nectar, on account of which the plant is sometimes called the honey-plant. Contrary to general belief the sap of milkweeds is not always milky, and that of *Hoya carnosa* is yellowish to amber in color and very bitter to the taste.

The wax-plant is a twiner, with stems 10 or more feet long, and is often trained as a permanent cover for a greenhouse wall. Nothing should be planted in front of it, for the plant is a sun-lover, and if grown in the shade the stems rot at the base. As a rule wax plants are easy of culture. They seem to thrive best in a mixture composed of two parts good fibrous loam to one of leaf mould and sand to which has been added some lime rubble and charcoal. The plant requires an abundance of water during the growing and flowering period, but it is advisable to keep it in a dry and cool atmosphere during the winter, beginning soon after flowering.

When the stems are allowed to creep on the ground they tend to send down roots, and new plants can then be cut from the main plant and potted as individuals. This method of propagation is known as layering. New plants may also be grown from cuttings. These should be grown in sand and syringed frequently until roots are formed. Rooting the leaves has been attempted, but although many adventitious roots have been produced no aerial shoot has ever appeared in almost two years. L. C.

EXPERIMENTS ON GLADIOLUS

Recent experiments on the gladiolus at the Garden have included forcing the corms in the greenhouse in the spring prior to planting them in the field. This variation in culture was designed to encourage flowering in June, thus avoiding much of the hot weather which frequently occurs in July and August, when the gladiolus normally blooms. The adaptability of selected varieties to St. Louis gardens was also ascertained.

Over one hundred commercial varieties of gladiolus, fifty corms of each variety, were started in the greenhouse, March 20, in three-inch pots containing fibrous loam soil. At the same time corms of each variety were stored for later planting in the field, to serve as checks on the dates of flowering and general growth responses. After forcing the plants in the greenhouse for thirty days, they were removed from the pots and planted outside. At this time the top growths were three to eight inches in height and vigorous root systems were well established. The check corms were planted with the forced stock and received identical treatment throughout the summer.

Soon after planting an extended period of dry weather occurred which eventually developed into one of the most devastating droughts on record. The intense sunlight, combined with the parching winds, provided a rigorous test of the drought resistance of all vegetation. Although the gladiolus

is not usually regarded as an appropriate subject for semi-arid conditions, a very satisfactory display of flowers was achieved by using over-head irrigation only twice during the entire growing season. The plants remained in bloom approximately one month, the forced stock flowering two or more weeks in advance of the checks. In fact, many of the check plants failed completely on account of the drought. The average length of time between planting in the pots and flowering in the field was ninety-two days. With greenhouse or hot-bed equipment this type of culture should be of value when early blooming is desired.

According to their respective attainments under adverse conditions, the varieties tested may be classified as "excellent," "fair," and "inferior." The failure of some varieties was attributed to deficient parent stock, and further trials are necessary to determine their normal merits. A few varieties produced vigorous plants, but the flowers wilted and sunburned so badly that they were a total loss.

Following is a summary of the data on the varieties of gladiolus tested at the Garden during the summer of 1934.

Excellent	Fair	Inferior	Further test necessary
Aflame—red	Alice Tiplady	Bagdad	Blue Danube
Aida—violet	Anna Eberius	Chicago White	Captain Boynton
Albania—white	Avalon	Coronation	Carnival
Albatross—white	Berty Snow	Flaming Sword	Chateau Thierry
Annie Laurie—flesh-pink	Byron L. Smith	Golden Amber	Commander Koehl
Antione—orange-yellow	Emile Aubrun	Heavenly Blue	Dr. F. E. Bennett
Apricot Glow—orange	Gay Hussar	Lily White	Dr. Nelson Shook
Buckeye—rose-pink	Illuminator	Loveliness	Fairy Lantern

Excellent	Fair	Inferior	Further test necessary
Bumble Bee—salmon-rose	Indian Summer	Maiden's Blush	Jane Addams
Cinderella—white-pink	Joe Coleman	Morocco	J. T. Pirie
Dr. Christ Martz—red	La Paloma	Paul Pfitzer	Los Angeles
Dr. Moody—lavender	Lincoln Ellsworth	Persia	Mrs. Dr. Norton
E. J. Shaylor—rose-pink	Little John	Pfitzer's Triumph	Mrs. Francis King
Elizabeth Tabor—rose-pink	Marie Kunderd	Primunella	Mrs. Leon Douglas
Golden Frills—yellow	Mammoth White	Ruth Huntington	Olive Goodrich
Jenny Lind—salmon-pink	Marmora	Saraband	Orange Butterfly
Joerg's White—white	Mary Frey	Seafoam	Primrose Princess
King of Orange—orange	Mother Machree	Venus	Prince of Wales
Marnia—orange	Mrs. F. C. Hornberger	Wilbrink	Richard Diener
Minuet—lavender	Mrs. F. Pendleton		Salbach's Pink
Mme. Norena—flesh-pink	Mrs. Ray P. Chase		
Mrs. Calvin Coolidge—salmon-pink	Nimrod		
Mrs. J. R. Walsh—flesh-pink	Orange Wonder		
Pearl of California—pure pink	Our Selection		
Picardy—shrimp-pink	Purple Glory		
Queen of Bremen—lavender-pink	Ruffled Gold		
Senorita—orange	Taro		
Souvenir—yellow	Tobersun		
Sword of Mahomet—dull red	Virginia		
Veilchenblau—violet-blue	1910 Rose		

A gladiolus disease known as neck-rot was conspicuous in the planting and destroyed some varieties, while others were partly or entirely immune. The following varieties showed substantial disease resistance:

Aflame
Aida
Albania
Albatross
Annie Laurie
Antione
Apricot Glow
Berty Snow
Betty Nuthall
Bleeding Heart
Bumble Bee
Charles Dickens
Cinderella
Dr. Christ Martz
Dr. F. E. Bennett
Edith Mason
Golden Amber
Golden Frills
Joerg's White
King of Orange
Mammoth White
Marmora
Marnia
Minuet
Mme. Norena
Mrs. Calvin Coolidge
Mrs. F. C. Hornberger
Mrs. Ray P. Chase
Nancy Hanks
Orange Wonder
Pearl of California
Pfitzer's Triumph
Picardy
Primrose Princess
Purple Glory
Queen of Bremen
Senorita
Souvenir
The Orchid
Virginia

Attention is directed to the fact that practically all of the varieties which were drought-resistant were immune to the neck-rot disease. There are of course many other fine varieties of gladiolus which should qualify for St. Louis gardens, and supplementary reports will appear as the information is acquired.

D. C. F.

NOTES

Dr. Hermann von Schrenk, Pathologist to the Garden, spoke before the American Association of Port Authorities, in New York, September 10, on "Marine Borers."

Mr. Lad Cutak, in charge of Exotics at the Garden, gave a talk at the Wednesday Dinner Club of Alhambra Grotto, September 19, on "Cacti in the Home."

Dr. George T. Moore, Director of the Garden, spoke before the Lake and Valley Garden Club, at Cooperstown, New York, September 10, on "Some Inside Facts About Plants—and the Missouri Botanical Garden."

The Garden Club of Overland, Mo., and the Garden Club of Gray Summit, Mo., visited the Garden Arboretum, September 30, and Mr. L. P. Jensen, Manager of the Arboretum, addressed both clubs on "The Missouri Botanical Garden Arboretum."

The third number of Volume XXI of the ANNALS OF THE MISSOURI BOTANICAL GARDEN, which consists of "Studies in Grindelia. II" by J. A. Steyermark, has recently been issued.

The Garden Club of Greenville, Ill., the women guests at the Missouri Bar Association meeting, and the Daughters of America-National Council visited the Garden recently and were conducted through the buildings and grounds by special guides.

Mr. A. P. Beilmann, Arboriculturist at the Garden, presented a paper before the National Shade Tree Conference, at Pittsburgh, August 30, on "Experimental Tree Feeding," and on September 28 he gave a talk before the Webster Groves Rotary Club, on "The Care of Trees."

The Greater St. Louis Association of Gardeners visited the Garden, October 7, and held their monthly meeting in the greenhouse. Mr. C. W. Stockwell, in charge of Japanese Beetle field work, Bureau of Plant Industry, U. S. Dept. Agr., gave a talk at the meeting on "The Japanese Beetle."

Mr. George H. Pring, Superintendent of the Garden, spoke at Fulton, Mo., September 27, before the Rotary Club, on "Economic Plants," and, in the evening, at a public meeting of the garden clubs, at the Theatre Building, on "Plant Exploration"; and before the Scottish Rite Woman's Clubs, at the Scottish Rite Cathedral, October 3, on "City Gardens."

Among those visiting the Garden library and herbarium recently were Dr. Harry J. Fuller, Assistant Professor of Botany,

and Dr. Constantin Alexoupolos, Instructor in Botany, University of Illinois; Dr. F. W. Pennell, Curator of Plants, Academy of Natural Sciences, Philadelphia; Mr. J. Horace McFarland, horticultural publisher and president emeritus of the American Rose Society, Harrisburg, Pa., and Mr. Robert Pyle, rose grower, West Grove, Pa.; Prof. J. C. Frazier, Assistant Professor of Biology, Illinois Wesleyan University, Bloomington, Ill.

STATISTICAL INFORMATION FOR SEPTEMBER, 1934

GARDEN ATTENDANCE:

Total number of visitors.....30,147

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought..... 18
Total number of books and pamphlets donated..... 121

PLANT ACCESSIONS:

Total number of plants and seed packets donated..... 125

HERBARIUM ACCESSIONS:

By Purchase—
Lundell, C. L.—Plants of British Honduras..... 124
Sydow, H.—"Fungi exotici exsiccati," Fasc. XIX, Nos. 901-950 inclusive 50
Sydow, H.—"Mycotheca germanica," Fasc. LIII-LVI, Nos. 2601-2800 inclusive..... 200

By Gift—
Barkley, Fred A.—Plants of Texas..... 58
Batchelder, Charles F.—Plants of eastern United States 750+
Berkeley, Earl E.—*Poria Cocos* (Schw.) Wolf from Mississippi 1
Beilmann, E. P.—Photographs of pine..... 2
Hills, Mrs. W. A.—Plants of horticulture..... 2
Pring, George H.—*Monotropa uniflora* L. from Missouri 1
Roediger, Miss Theodora W.—*Morus alba* L. from Missouri 1
Schrenk, H. von—*Arceuthobium pusillum* Peck from Wisconsin 25
Spencer, E. R.—Fruit of *Juglans nigra* L. from Illinois 1
Johnson, C. O.—*Celtis occidentalis* L. 1
Teas, E.—*Bignonia* sp. from horticulture..... 1
Tesson, Michael—*Datura suaveolens* Humb. & Bonpl. from horticulture 1
Tuttle, Mrs. George—*Argemone alba* Lestib. from Missouri 1

White, Mrs. Verner Moore—*Lepiota* sp. from Missouri.. 1
Williams, Louis—Plants of Wyoming..... 9
Williams, Louis—Plants of Wyoming collected by Dr. W. B. Sheppard..... 90
Williams, Louis—Plants of Oregon..... 23
Woodson, R. E., Jr.—Apocynaceae..... 4

By Exchange—
Rocky Mountain Herbarium by Prof. A. Nelson, plants of the Rocky Mountain region..... 685
University of Missouri Herbarium by Francis Drouet, miscellaneous Algae 23

By Transfer—
Lodewyks, Maude C.—*Caryopteris Mastacanthus* (Endl.) Schau., plant of horticulture..... 1

Total.....2,055

SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date to the death of Mr. Shaw, in 1889, the Garden was maintained under the personal direction of its founder, and while virtually a private garden it was, except at certain stated times, always open to the public. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was designated by Mr. Shaw as its official title and in his will or in any of his writings he specifically referred to it as the "Missouri Botanical Garden." By a provision of Mr. Shaw's will the Garden passed at his death into the hands of a Board of Trustees. The original members of the Board were designated in the will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will, the immediate direction of the Garden is vested in a Director, appointed by the Board of Trustees. The Garden receives no income from city or state, but is supported entirely from funds left by the founder.

The city Garden comprises 75 acres, where about 12,000 species of plants are growing. There is now in process of development a tract of land of over 1,500 acres outside the city limits which is to be devoted to (1) the propagation and growing of plants, trees, and shrubs, designed for showing either indoors or outside, at the city Garden, thus avoiding the existing difficulties of growing plants in the city atmosphere; (2) gradually establishing an arboretum as well as holding a certain area as a forest reservation, with the idea that possibly at some future time this may become the new botanical garden.

The Garden is open to the public every day in the year, except New Year's Day and Christmas—week days from 8:00 a. m. until one-half hour after sunset; Sundays from 10 a. m. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Place, on the Sarah car line (No. 42). Transfer south from all intersecting lines.

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OF THE MISSOURI BOTANICAL GARDEN

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MISSOURI BOTANICAL GARDEN BULLETIN

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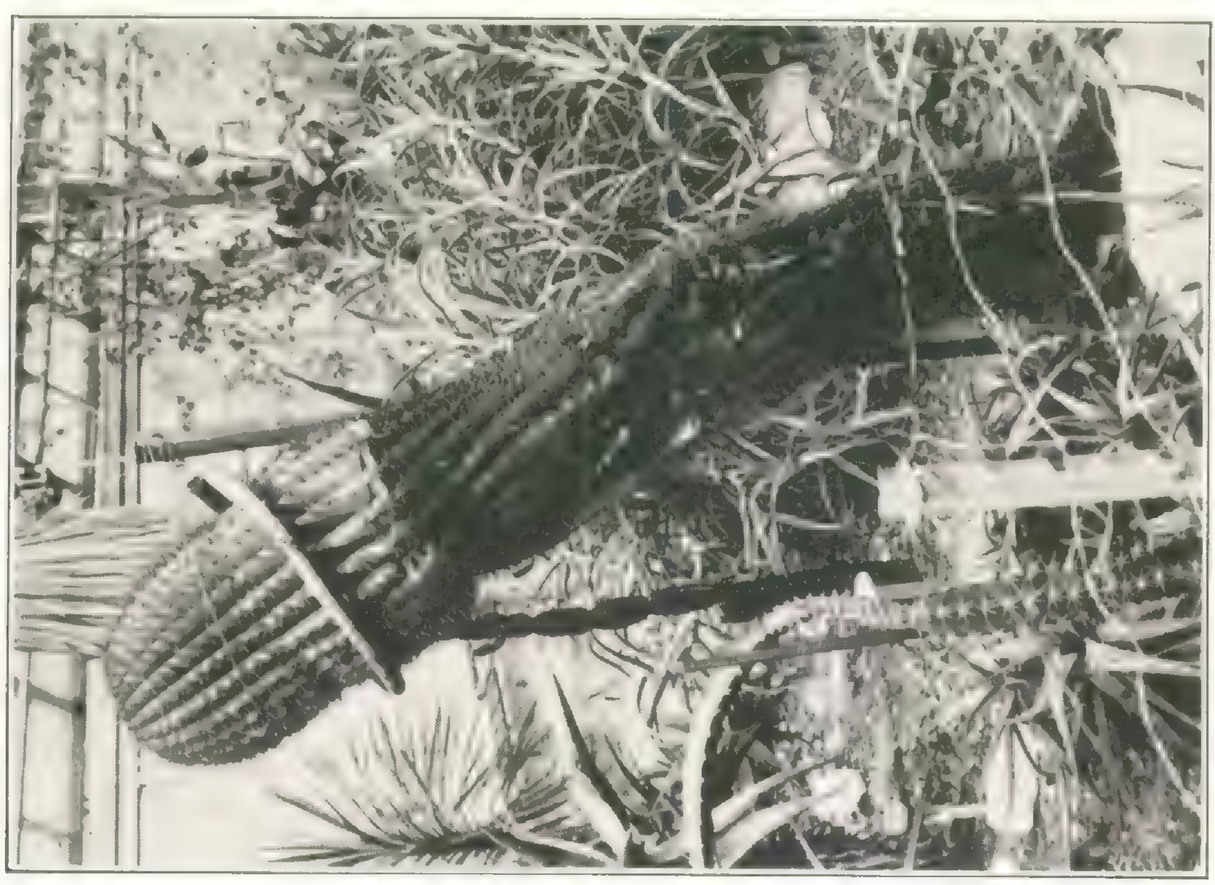

SPECIMEN OF SAGUARO, SHOWING THE DEVASTATING WORK OF BACTERIAL ROT

Missouri Botanical Garden Bulletin

Vol. XXII NOVEMBER, 1934 No. 9

THE PASSING OF THE SAGUARO (CARNEGIEA GIGANTEA) AT THE GARDEN

The characteristic appearance of Arizona's landscape is largely due to those grotesque sentinels of the desert, the saguaros *(Carnegiea gigantea)*. Despite their massive proportions they are graceful, and for this reason and the fact that they are such great curiosities they are eagerly sought for every cactus collection. In their native habitat the huge watery cylinders grow very slowly. Instead of the roots extending deep into the soil, as do those of the mesquite and creosote bush, they extend laterally just below the surface for a distance of fifty feet or more. Thus when water is available a quick supply is insured within that radius and is stored in the huge stems against the long periods of drought.

As a rule these plants do not live long in conservatories. On digging them up for shipment, it is necessary to cut off the long lateral roots, and in most cases new rootlets do not replace the severed ones. Incidentally, the plant lives for many years on the supply of water stored in its thickened stem.

In June, 1914, a specimen of the saguaro, measuring about eleven feet in height and weighing over a thousand pounds, was received at the Garden and planted in the yucca dome of the Main Conservatory. The following year it was removed to the Succulent House, where it flourished for several years.

In 1919 it flowered meagerly, but in the latter part of that year the great mass of plant rotted, leaving only its many perpendicular fibro-vascular bundles.

In 1922, through Mr. W. T. Swingle, of the Bureau of Plant Industry, there was received another specimen, measuring eight feet in height and weighing approximately eight hundred pounds. It stood majestically in the Desert House until the memorable hail storm of May, 1927, when it was battered by the falling glass and finally killed by the ensuing summer rains.

Still another specimen was received from Dr. Forrest Shreve, of the Desert Laboratory, on May 10, 1928, and it flourished until the past summer. On several occasions this seven-foot giant was slashed by vandals, these dastardly acts indirectly contributing to the death of the plant. An open wound is an invitation to bacterial disease, and it was not long before rot set in. This was promptly treated by removing all decayed tissue and permitting a callus to form. Some months later another wound was discovered, near the base, which had already wrought considerable damage. It was hoped that all source of danger had then been removed, but this past spring bacterial rot set in at the base working upward through the center (pl. 53, fig. 1). There was no way of saving the plant this time, and this past fall another giant went the way of the preceding two. The average life of these saguaros after being transplanted from their native home is seven years.

The framework of the saguaro is very interesting (pl. 53, fig. 2). It consists of a circle of long light poles, thickened at their bases and tapering toward the tops. This is just another engineering feat of Nature to support these huge watery cylinders against the winds of the desert.

In most cases the growth of the saguaro is slow and irregular. It may grow three feet in thirty years, after which the yearly growth may average four inches. Assuming that the last Garden specimen grew at this rate, its age would be estimated at fifty years or more. Many of the saguaros in Arizona are reputed to be over two hundred years old.

L. C.

THE VEILED PROPHET'S QUEEN'S ORCHID BOUQUET

The fragile, fairy-like appearance of many orchids gives the misleading impression that they are delicate blossoms, with an ephemeral beauty lasting only for a day or two. This year it was possible to check their keeping qualities and make an authoritative record of their longevity. A duplicate of the Veiled Prophet's Queen's bouquet was made for display purposes, and the flowers were therefore not subjected to high temperature or handling other than required to arrange the bouquet.

The orchids were cut from the plants at Gray Summit on Tuesday, October 2, about noon, and reached St. Louis at five o'clock that evening. They were then placed in water until the following evening, when they were removed and made into the bouquet which was placed on display at eight A.M., Thursday morning. After the bouquet was constructed it was impossible to put the flowers in water, and the problem of supplying necessary moisture was a difficult one. The refrigerated show case in which the bouquet was displayed in the Garden's Floral Display House was kept at a temperature of 50°–53° F. Since the nights were cool the doors of the case were opened at sundown and the refrigeration turned off. During the night the moisture from the greenhouse condensed on the inside of the case, and at eight o'clock the next morning the doors were shut and the refrigeration once more resumed. Since the size of the case did not permit the use of vaporizing apparatus, the only water given the bouquet was through this condensation from the air each night.

The following Thursday, one week after the flowers were on display, and eight days after they were removed from the water, the Cattleyas and *Dendrobium Phalaenopsis* were beginning to show some signs of wilt. Four of the Cattleyas were removed, but the remainder of the bouquet was left on display until the next evening. The bouquet was then taken out of the case, dissembled, and the flowers placed in water

at ordinary room temperature. The orchids had been out of water for nine days altogether, but many of the flowers, notably *Dendrobium superbiens* and the slipper-orchids (Paphiopedilums), showed no serious wilting. In fact, at the date of this writing, October 12, specimens of these two kinds appeared to be in good enough condition for another week of display, but, it must be admitted, only if kept under favorable moisture and temperature conditions.

Following is a list of the orchids used in the bouquet:

Cattleya labiata
Cattleya Bowringiana
Laelio-Cattleya hybrids (20 varieties)
Brasso-Cattleya hybrids (5 varieties)
Paphiopedilum hybrids (10 varieties)
Oncidium Lanceanum
Brassavola nodosa
Epidendrum radiatum
Epidendrum fragrans
Dendrobium Phalaenopsis var. *Schroederianum*
Dendrobium superbiens
Phalaenopsis Esmeralda
Phalaenopsis rosea
Aerides odoratum

THE EFFECT OF THE HEAT AND DROUGHT ON PLANTS AND TREES CULTIVATED AT THE GARDEN AND ARBORETUM

While what has properly been called "the great drought of 1934" may not have been the worst in history, it certainly was the worst in the life of the Missouri Botanical Garden. Its effect on agricultural crops has been widely noted, and the fact that, according to the Weather Bureau records for June 1933 to August 1934, Missouri had the greatest moisture shortage of any state will be readily appreciated by those trying to grow plants of any kind in the vicinity of St. Louis. For many of the plants grown at the Garden the intense heat was quite as detrimental as the lack of rain. In fact, where water could be applied the only damage was due to continued high temperature, but that in some cases was considerable.

While it is too soon to determine what may be the ultimate effect of drought and heat on outdoor trees and shrubs, it is thought that the following notes, prepared by various members

of the staff, may be of interest to plant lovers who will long remember the past summer.

Arboretum, Gray Summit, Mo.—On May 14 it rained all day. On June 9 and 10 there was a rain of fifteen hours' duration. On July 27 it rained four hours, and on August 15 and 16 an eighteen-hour rain with cooler weather terminated the extremely dry season. From June 14 until August 14 there were but four days when the thermometer did not reach 100° F. July 23 and 24 held the maximum record of 114° F. Owing to this long period of high temperatures almost all the seedlings of the present year's seeding in the nursery were killed. By shading and watering, the majority of the older seedlings were carried through the dry period without apparent injury.

Of the conifers planted in the open, *Taxus cuspidata* and its variety *brevifolia* were killed. All the Thujas were badly burned and many varieties were killed. *Abies balsamea* was killed, and *Picea Engelmannii, P. Alcockiana, P. excelsa,* and *P. alba* were seriously burned. Among the pines, the white pine *(Pinus Strobus)* was the only one which suffered serious injury. *Juniperus chinensis* var. *procumbens* was killed, and some large specimens of *J. virginiana* var. *columnaris* were also lost.

The actual loss among the deciduous trees and shrubs was comparatively small, so far as can be detected. The leaves of magnolias were badly burned, as were those of *Cornus florida, Prunus virginiana, Acer ginnala* and *A. japonicum, Sorbus Aucuparia* in part, *Syringa villosa,* varieties of Diervilla, *Corylus rostrata, Symphoricarpos occidentalis,* and *Syringa amurensis.* Azaleas and rhododendrons suffered severely. Many were killed in locations where water was not available, but in the nursery, where they could be watered, they were not injured.

At present the only serious loss of the native arboreous vegetation in the Arboretum seems to be individual trees of several species which were growing in shallow soil in rocky situations.

Moisture and Temperature Relations in Trees.—Until 1934, the various Asiatic species of trees which have been introduced into American gardens appeared to answer the question regarding a tree suitable for dry situations. However, on July 18 they completely collapsed, along with some of the native species. From studies of increment borings made in 1933 the exotic species were able to make a nearly normal growth with the very little water available that year, but these studies did not show how nearly these trees were to the danger line. Studies of borings taken from native trees during that year indicated a more economical use of water, which resulted in a reduced growth rate. Perhaps this might be termed adaptability. Of the native trees the bald cypress seemed most adaptable, not losing a single leaflet, next came the sassafras, then the oaks and hickories. The hard maples (when not severely scorched) were not so seriously injured as the black locust, linden, or sweet gum, all of which shed many (in some cases 50 per cent) of their leaves. The ash and cottonwood and elm were seriously injured, but not nearly as much so as the soft maple which has further proven its unsuitableness as a lawn tree. Of the Asiatic species, only the Sophora and Ginkgo (if of large size) showed little or no injury. The others collapsed, the Ailanthus leading the list. Increment borings taken over a period of several weeks showed that wilting usually occurred when there was less than 50 per cent moisture as determined gravimetrically. Moisture determinations taken July 27 showed the following variations:

Linden, 51.2 per cent
Soft maple, 37.9–65.5 per cent
Horse-chestnut, 51.5–54.3 per cent
Chinese cork, 67.7–69.0 per cent
Ginkgo, 45.4–42.9 per cent
Ailanthus, 50.1–49.4 per cent
Sassafras, 87.3 per cent
Sycamore, 70.5–77.0 per cent
Oak, 55.4–65.2 per cent
Locust, 67.4 per cent

In connection with the moisture determinations, many interior temperature readings of trees were taken. It was found that a tree might have a temperature internally of 86° F. for a short time without wilting. It might even reach this temperature before shedding any of its leaves, but wilting would begin the next day unless water were supplied. Thus water shortage

previous to wilting could be determined by the use of a thermometer. In many cases interior temperatures reached 84° or 85° several days before the tree showed any signs of distress. Such temperatures, of course, occur only in large trees whose trunks are in shade and only in such seasons as 1932, 1933, and 1934. The highest interior tree temperature recorded was for a large soft maple (entirely without leaves), 105.8° F. The highest temperature for a small tree occurred July 18, when a small ginkgo registered 115.7° F.

The following temperature records of the soil are interesting. On August 10, 1934, the temperature 1 inch below the surface in the cultivated part of the Iris Garden was 105.8° F.—under the grass it was 103.2° F. In the Economic Garden 1 inch below the surface in cultivated soil, 98.6° F.—1 inch below surface grass, 96.8° F.—6 inches below surface grass, 91.4° F. Under the bent grass 1 inch below surface, 98.6° F.—6 inches below surface, 91.4° F.—shaded portion, 87.8° F. Open lawn (unwatered) 6 inches below surface, 98.6° F.

Effect on Herbaceous and Bedding Plants.—Shallow-rooted annuals and perennials that had been frequently watered during the dry period produced a normal growth. Some foliage was burned, and plants that failed to get sufficient water showed the effects of the drought and heat. However, after the rains of mid-August the herbaceous plants began to grow, and in late September gave every indication of having fully recovered. Had the heat wave continued, even though rains did fall in August and September, the damage to plants would have been more pronounced. However, since much cool and cloudy weather has prevented the rapid evaporation of the soil moisture the plants have produced a lush growth similar to that occurring in spring; in fact, since mid-August all vegetation in this region has been reveling in a second spring, and the season will be long enough for the plants to ripen properly before the winter resting period. Perennials near trees and shrubs naturally suffered most, as they were dependent upon moisture in the upper layer of soil, and this was soon consumed by the larger plants or exhausted by the hot winds.

That the lack of moisture was the limiting factor in the growth of plants was clearly demonstrated in flower beds watered with stationary sprinklers. Frequently during the summer, portions of some beds failed to get a thorough soaking, and after several weeks the plants showed the effects of the lack of moisture. In installing permanent sprinkling systems some thought should be given to the location of the sprinkler heads with respect to the prevailing southwest winds which are almost always blowing with considerable velocity during a dry spell.

Plants loving warmth, such as coleus and other tropical foliage plants, grew to perfection provided they received sufficient moisture. The Italian Garden, where foliage plants were largely used, was excellent this year, but to attain that condition sprinklers were usually run every day, and if more than two days elapsed between waterings the plants wilted.

Most of the annual-flowering plants were unaffected by the summer. The California poppies, sun-moss, verbenas, and vincas fairly thrived on a minimum supply of water. One would naturally expect a South African annual, such as Venidium, to be at its best during a hot summer, but that was not the case. South Africa enjoys cooler nights, and *Venidium fastuosum,* whether grown in full sun or partial shade in this region, has not grown as well as other annuals. It can be grown to perfection under glass in early spring, but not so outdoors.

After a dry and hot spring, the red spider is one of the most serious pests. It can defoliate roses and other plants in a few days, but precautionary measures were taken at the Garden. The enforced resting period of roses, due to defoliation in mid-June, temporarily spoils their appearance. However, by the end of August they are again completely clothed in rich, green foliage and blooming profusely, the flowers continuing until frost.

Whether the drought and heat have caused any injury to peonies and iris is a question that can only be answered with certainty next spring. However, growing conditions have been ideal since the middle of August, a period when flower-

buds for next season are forming, and it can be almost safely predicted that peonies and iris will show very little, if any, after-effects of the drought. Peonies that lost their foliage early in the season, due to a location near shrubs or large trees, will not bloom, but those that had green foliage until late August and early September should bloom next year.

Whether greenhouses in which chrysanthemums are grown should have the roofs lightly shaded during the summer has been a point of controversy for years. In the middle-west roofs should be shaded, especially during such a season as the one just past, if the burning of the foliage is to be prevented. By careful watering the single-stem chrysanthemums at the Garden have been successfully carried through the summer. Greenhouse temperatures at times registered 115 degrees F. and higher during the day, the average being between 110 and 112 degrees, with a minimum of about 80 degrees. When such heat continues week after week the plants languish, but with cooler weather they respond to the changed conditions.

The Orchids and Other Tropical Plants.—Although the heat of June and July was unremitting, it did not exceed 100° F. in the greenhouses, and little apparent damage was done to the majority of plants. However, with a sudden rise to 110° F., a period of extreme heat was ushered in. The registered temperature inside the orchid houses at Gray Summit was at times as high as 115° to 120° F., and this necessitated watering the plants twice a day and applying additional shade on the roof glass.

The Paphiopedilum (Cypripedium) buds in various stages of development dried up almost immediately. *Phragmopedilum caudatum,* a species which grows normally at an elevation of 5000 feet, yellowed, and the two plants in the town orchid houses died. In the Paphiopedilums of the higher altitudes, particularly *P. insigne* and its hybrids, the foliage turned yellowish-green. If growth were an indication, the East-Indian group, such as *P. Lawrenceanum* and *P. callosum* and their various hybrids, seemed to enjoy the heat, but the flower buds were killed.

There was a decided yellowing of the foliage in the Cattleyas and Laelias. The few flower shoots that pushed through the sheath were in a weak condition and bore small flowers. During the extreme heat in July and August, there was a noticeable paucity of blooms. With the exception of *Vanda coerulea*, the Vandas seemed to delight in the high temperatures. Plants of allied genera, Aerides, Saccolabium, etc., shared this heat-loving characteristic.

The terrestrial orchids, including Peristeria, Calanthe, and Phaius, which had been in excellent condition, were burned at the foliage tips immediately after the temperature climbed to 110° F. Five plants of Peristeria, which were unfolding their buds, became brown two days later.

As stated previously, most of the plants withstood the summer very well until the extreme temperature arrived. The exceptions to this were the Odontoglossums and Trichopilias, which had been collected in Pamama at altitudes above 7000 feet. These suffered severely even during the 100°-temperature spell in June and July. Some plants died after the jump to the extreme temperatures, others showed yellowing of both leaves and pseudobulbs, resulting in a very weakened condition.

The group of orchids which seemed to delight most in the extreme heat were the Dendrobiums, including *D. nobile* and the Australian and Philippine species. The stem-like pseudobulbs now show a greater increase in growth than that of previous seasons.

With the approach of lower temperatures and increased moisture content, all the orchids have again assumed their normal green color. A final check will show very little actual loss, except in those genera growing naturally at high altitudes.

In the city greenhouses the tropical plants had their old foliage prematurely yellowed and burned wherever roof-shade was not heavy. The aerial Bromelias, which in the tropics grow on branches exposed to full sunlight, registered a strong reaction against extreme temperatures. *Aechmea fulgens* var. *discolor*, of which the Garden has about ten plants, assumed the

appearance of an old growth after flowering because of a total drying-up of the leaves. This condition was only temporary, however, since young growths are now coming from the base. The Bromelias with the leathery type of leaves did not show any damage from the extreme heat.

Among the ferns in the large conservatory, *Cibotium Schiedei* was conspicuous with its burnt foliage.

NOTES

Dr. Hermann von Schrenk, Pathologist to the Garden, has been elected president of the American Society for Testing Materials.

Dr. Hermann von Schrenk gave a talk before the University of Illinois Chapter of the American Society of Civil Engineers, October 31, on "Timber."

Mr. Paul A. Kohl, Floriculturist to the Garden, spoke before the Garden Club of Ferguson, Mo., October 17, on "Bulbs"; and before the Council of Jewish Women, November 5, on "Preparing the Garden for Spring Planting and Winter Protection."

Recent visitors to the Garden were Mr. Waldemar Meier, Horticulturist, of the Park Department, Berne, Switzerland, who has been associated with the Swiss Village at The Century of Progress Exposition, Chicago; and Mr. J. Christian Bay, Librarian, John Crerar Library, Chicago, Ill.

Dr. George T. Moore, Director of the Garden, spoke before the Garden Club of St. Louis, October 16, on "Mysteries of the Underworld or What Goes on Underground"; and on November 13 he discussed "The Life of the Plant," illustrated with moving pictures, before the Kirkwood Garden Club No. 2.

Mr. George H. Pring, Superintendent of the Garden, spoke before the Garden Club of Greenville, Ill., October 24, on "City Gardens"; before the Associated Garden Clubs of Kansas City, October 29, on "Water-lilies and Garden Pools"; and before the St. Louis Horticultural Society, November 2, on "Evolution of the Cultivated Chrysanthemum."

STATISTICAL INFORMATION FOR OCTOBER, 1934

GARDEN ATTENDANCE:

Total number of visitors.....47,027

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought..... 47
Total number of books and pamphlets donated..... 24

PLANT ACCESSIONS:

Total number of plants and seed packets donated..... 109

HERBARIUM ACCESSIONS:

By Purchase—
Williams, Louis—Plants of Oregon..... 270

By Gift—
Bakke, A. L.—*Centaurea* from Iowa..... 2
Barkley, F. A.—Plants of Mississippi..... 2
Barkley, F. A.—Plants of Oklahoma..... 20
Bettis, Mrs. Jas. R.—*Bauhinia purpurea* L. from Horticulture 1
Dodge, Carroll W.—*Senecio* from Central America..... 4
Eilbracht, W. E.—*Solanum urbanum* Morong from Horticulture 1
Fairburn, David—*Cosmos sulphurea* Cav. and *Malcomia maritima* R. Br. from Horticulture..... 2
Fuller, Geo. D.—*Atriplex hortensis* L. from Horticulture 1
Hanna, L. A.—Plants of the United States..... 700±
Kellogg, John H.—Plants of Missouri collected by B. F. Bush..... 116
Lehmann, Mrs. M. S.—Specimen and photograph of *Opuntia* 2
Pring, Geo. H.—Plants of Colombia, S. A..... 2
Purpus, C. A.—Plants of Mexico..... 2
Schrenk, H. von—*Lycium chinense* Mill. from Horticulture 12
Schrenk, H. von—Plants of Texas..... 2
Williams, Louis—Plants of Missouri..... 2

By Exchange—
Pennell, F. W.—*Baptisia* sp. from Kansas..... 1
U. S. National Museum—Lichens from Argentina..... 2
University of Minnesota, by C. O. Rosendahl—Plants of Minnesota 106
Williams, Louis—Plants of Wyoming..... 11

By Transfer—
Hunter, A. A.—Orchid from Panama..... 1
Pring, Geo. H.—Orchids from Horticulture..... 5

Total..... 1,267

SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date to the death of Mr. Shaw, in 1889, the Garden was maintained under the personal direction of its founder, and while virtually a private garden it was, except at certain stated times, always open to the public. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was designated by Mr. Shaw as its official title and in his will or in any of his writings he specifically referred to it as the "Missouri Botanical Garden." By a provision of Mr. Shaw's will the Garden passed at his death into the hands of a Board of Trustees. The original members of the Board were designated in the will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will, the immediate direction of the Garden is vested in a Director, appointed by the Board of Trustees. The Garden receives no income from city or state, but is supported entirely from funds left by the founder.

The city Garden comprises 75 acres, where about 12,000 species of plants are growing. There is now in process of development a tract of land of over 1,500 acres outside the city limits which is to be devoted to (1) the propagation and growing of plants, trees, and shrubs, designed for showing either indoors or outside, at the city Garden, thus avoiding the existing difficulties of growing plants in the city atmosphere; (2) gradually establishing an arboretum as well as holding a certain area as a forest reservation, with the idea that possibly at some future time this may become the new botanical garden.

The Garden is open to the public every day in the year, except New Year's Day and Christmas—week days from 8:00 a. m. until one-half hour after sunset; Sundays from 10 a. m. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Place, on the Sarah car line (No. 42). Transfer south from all intersecting lines.

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OF THE MISSOURI BOTANICAL GARDEN

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MISSOURI BOTANICAL GARDEN BULLETIN

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A MIMIC PLANT, PLEIOSPILOS SIMULANS

FLOWER OF PLEIOSPILOS SIMULANS JUST BEFORE CLOSING

Missouri Botanical Garden Bulletin

Vol. XXII DECEMBER, 1934 No. 10

A PLANT THAT LOOKS LIKE A ROCK

Among the Mesembryanthema, so rich in plant forms, is a group popularly called mimic plants. The leaves of plants in this group resemble broken rock fragments so strikingly that when the plants were put on exhibition they were literally "touched to death." Very few persons could resist the temptation to convince themselves that they were truly living plants. The first of these stone-like plants was described about the year 1870, receiving the name of *Mesembryanthemum Bolusii,* in honor of the authority on South African flora, Harry Bolus. A few years ago an intensive study of Mesembryanthema was undertaken by N. E. Brown of Kew, Dinter and Schwantes of Germany, and Louisa Bolus of South Africa, with the resultant splitting of the genus Mesembryanthemum into many new genera. The name Pleiospilos was given to that particular group known as mimic plants, the name being derived from the Greek, meaning "full of spots or dots," on account of the thickly dotted leaves. Probably the most striking of all the stone-like Mesembryanthema is *Pleiospilos simulans,* aptly named for its simulating stones among which it grows.

Pleiospilos simulans and *P. Bolusii* are hardly distinguishable in their seedling stages, and even in mature plants the differences are noticed only by an alert observer. The leaves of *P. simulans* do not have the large bulge beyond the tips as in *P. Bolusii,* but they have a pronounced keel like that of a sail-

ing boat. They also tend to curve back, unlike those of *P. Bolusii.* The flowers, though alike, are much larger in *P. simulans.*

In 1931 about thirty plants of *P. simulans* raised from seed were received at the Garden through S. R. Long, Superintendent of Parks of Port Elizabeth, South Africa. This species has been described as stemless and its flowers as sessile, yet one of these three-year-old seedlings (the chief reason for this article) developed a stem almost two inches in length. It also bore four pairs of leaves and tended to be somewhat cespitose, very unusual features for this plant. Normally the old leaves wither when the new ones develop and the plant has only two or three pairs of leaves at a time. The bright yellow flowers appeared at the junction of the leaves and gave forth a strong and pleasant odor similar to the flowers of the leguminous climbing plant, *Camoensia maxima,* which bloomed for the first time at the Garden in 1928. N. E. Brown likens the odor to that of fresh coconut.

A few notes on the flower may be of interest. It opened on October 1, 1934, at exactly 4:20 o'clock in the afternoon and closed at 7:00 o'clock that same evening. Plate 54, fig. 2, shows the flower just fifteen minutes prior to its closing. This regularity in the opening and closing of the flower lasted for four days, and from then until the tenth day the flower opened earlier in the afternoon, at about 3:00 o'clock. In closing, the flowers assumed an orange color due to the pinkish tint of the outside surface of the petals being reflected through the bright yellow of the inside surface. The petals became decidedly red on withering.

Description.—Leaves larger than those of *P. Bolusii,* about 80 mm. (3 inches) long, 20 to 40 mm. (¾–1½ inches) broad, and about 25 mm. (1 inch) in thickness; surface smooth, gray-green, thickly dotted with dark green, flat on the face, distinctly keeled underneath, usually recurved-spreading. Flowers at the junction of the leaves, shortly pedunculate (not sessile as often described), 60 mm. (about 2½ inches) or more in diameter, with a pair of keeled bracts similar in color to the leaves; petals numerous, linear, (about 1 mm. wide), bright

NATIVE SPIDER LILY (*Hymenocallis occidentalis*)

yellow on the inner surface fading to white towards the base, whitish to pale pinkish on the outer surface; calyx with 6 grayish-green, faintly spotted lobes, inner margins membraneous; stamens very numerous, with white filaments and deep yellow anthers, almost completely hiding the filiform stigmas.

L. C.

NEW OR NOTEWORTHY PLANTS FOR ST. LOUIS. VI

THE NATIVE SPIDER LILY

Our native and only hardy spider lily is *Hymenocallis occidentalis*, a member of the Amaryllis family. It is found growing in sandy and marshy ground along streams and creeks, and seems to be rather plentiful in Butler County. Some years ago, while visiting in Kentucky, my attention was attracted to a large vase of this spider lily displayed in the hotel lobby. I was informed that they had been gathered that morning a short distance from the hotel, and the porter offered to show me the location. There I found hundreds of plants growing in the sandy creek bottoms. I collected some of the bulbs and planted them in my garden in St. Louis, where they increased and bloomed for years. The spider lily is a really desirable bulbous plant for St. Louis gardens. It has been growing at the Missouri Botanical Garden Arboretum for the past two years and has proved to be perfectly hardy. The flowers, which are delicately fragrant, bloom during late August and early September. Offsets from the bulbs are plentiful, and seeds are easily obtained. They should be grown in rich moist soil

A. G. Ulrich.

ECONOMIC USES OF PLANT SAP. I

The significance of plant sap in the manufacture of many commercial products is comparatively little known. The average individual has no idea where or how sugar, rubber, various drugs, beverages, and other plant derivatives are obtained. In the series of articles which will appear in the Garden Bulletin the origin, methods of preparation, and uses of the most important products of plant sap will be considered. The first deals with one of the world's most staple food substances:

SUGAR

The manufacture of sugar is one of the leading industries and an extensive branch of international commerce. Sugar is obtained from the sap of sugar cane, sugar beet, sorghum, maple tree, and various palms. The common white sugar is manufactured from cane and beets, the estimated production for 1933-34 being 25,286,604 long tons.

Sugar cane.—British India, Cuba, Philippine Islands, Brazil, Hawaiian Islands, and Porto Rico are the principal sources of sugar cane, and there are limited plantings in Louisiana, Florida, and other southern states. Large quantities of raw cane sugar are shipped to the United States for refining, and in recent years considerable refined sugar has been imported, especially from Cuba.

Sugar cane *(Saccharum officinarum)* is a tropical perennial grass attaining a height of 8 to 15 feet or more. The plants are started from cuttings and require approximately ten months to reach the harvesting stage, at which time the sap contains from 7 to 20 per cent sugar depending on the variety of cane, climate, and cultural practice. After harvesting the canes are sent to the mill where the fresh stalks containing as much as 90 per cent sap are crushed between powerful steel rollers. The expressed juice is heated, clarified by the addition of lime, and concentrated to a thick syrup by boiling in evaporators. When the syrup becomes sufficiently concentrated the sugar crystallizes out and is separated from the residual molasses in centrifugal machines. The raw sugar resulting from this process is further purified and upon recrystallization it becomes perfectly white. This is the finished product which appears on the market as granulated, loaf, and pulverized sugar. Yellow and fancy sugars are obtained by regulating the acidity of the cane juice during the clarification process.

The molasses is marketed as molasses, mixed with cane pulp and sold as a fodder for livestock, manufactured into rum, used as fuel, or returned to the soil as a fertilizer.

Sugar Beet.—About one-third of the total sugar used comes from the sap of the sugar beet, a variety of the common garden

beet *(Beta vulgaris)*. The sugar of the beet is identical in every way to that of cane. Europe leads in the production of sugar beets, with extensive plantings in Germany, Russia, France, and Czechoslovakia. California, Colorado, Michigan, Utah, and Nebraska are the important sugar-beet regions in the United States.

Sugar beets are raised from seed, and the roots are harvested in the fall when the leaves turn yellow. The roots are sent to the factory where they are thoroughly washed, sliced into thin pieces, and the sugar extracted by diffusion in warm water. The juice, which usually averages from 11 to 14 per cent sugar, is clarified by adding large quantities of lime, then it is filtered and evaporated until the sugar crystallizes out, leaving the molasses. Further refining of the beet sugar is very similar to that of the cane product. The beet pulp and foliage are used as feed for livestock.

Sorghum.—Sugar can be obtained from the sap of certain varieties of sorghum or broom corn, but it is difficult to crystallize and therefore the juice is generally used in the form of syrup. Sorghum is commonly grown to supply the needs of individual farms, but there are a few commercial sorghum factories which absorb large plantings of this crop. The southern states produce most of the sorghum syrup, which amounts to about 25,000,000 gallons annually.

Sorghum *(Holcus Sorghum)* is a tall coarse annual grass which is raised from seed. Like sugar cane, the crop must be harvested at just the right stage of maturity to produce a fine grade of syrup. Usually when the seeds become hard the leaves are stripped from the stalks and the crop is cut. The sap, which contains approximately 10 to 14 per cent sugar, is extracted by crushing the stalks between steel rollers. The impurities are then removed and the juice evaporated to syrup, which should be light in color, mild, and of a fine flavor. It is used extensively as a table and culinary syrup. The by-products of sorghum are used mainly as stock feed.

Maple sugar.—In the colonial days maple sugar and syrup were staple foods, and the year's supply of sugar was obtained by tapping the maple trees in the spring. In 1875 cane sugar

began to undersell maple sugar, and today maple products are regarded as luxuries. The volume of maple sugar was reduced to about 20,000,000 pounds in 1930, or less than 50 per cent of the quantity produced in 1890. The maple products industry is now centered in Vermont, New York, Ohio, Pennsylvania, New Hampshire, and the Canadian province of Quebec. Prior to 1900 more sugar than syrup was made, but at the present writing about 90 per cent of the maple products are marketed as syrup. The majority of the syrups sold today are blended or adulterated, and pure maple syrup is indeed a delicacy.

All maples have a sweet sap, but the amount of sap produced and its sugar content render some species of little value for tapping. The sugar or hard maple *(Acer saccharum)* and the black maple *(Acer nigrum)* are the sources of most of the maple products.

The flow of sap in the spring of the year is one of Nature's remarkable reactions about which very little is definitely known. However, the popular belief that the sap is stored in the roots from which it rises in the spring is far from correct. When the trees are first tapped, more sap comes from above than from below the tap hole 3 to 5 feet from the ground line. The great variation of pressure within the tree seems to affect the flow, freezing nights followed by warm mild days stimulating the movement of the sap. The sugar season begins in February or March and may continue three to nine weeks depending on the prevailing weather conditions. The sugar is manufactured in the leaves and moved to various parts of the tree. Toward fall it is stored as starch in the branches, trunk, and roots. In late winter and early spring, when the weather moderates, the starch is converted back to sugar and the sap begins to flow. When the tree starts to grow the sap changes in flavor and texture, making it worthless for syrup or sugar.

Maple sap is composed of water, sugar, and mineral and organic substances. The sugar content of the sap may vary from 2 to 7 per cent or more, depending on the cultural practice, season, and the individual characteristics of the tree. It requires about 33 gallons of sap containing 3 per cent sugar to make

one gallon of syrup which in turn will make eight pounds of sugar. The quality and quantity of the sap produced are not constant, the average flow for a season being about 25 quarts to a tap, with two to three taps per tree. To yield satisfactory returns, the hard maple must usually be 60 to 150 years old or 10 to 12 inches in diameter 5 feet from the ground.

The trees are generally tapped on the trunk from near the ground up to 5 feet or more. The tap hole should be made with a sharp bit about ½ inch in diameter, and the hole should not be over 3 inches in depth as most of the sap comes from the white sapwood which occurs in the outer 2 to 3 inches of the trunk of large trees. In this hole a wooden or metal spout is then inserted, on which a bucket is hung to catch the sap. The number of buckets depends on the size and vigor of the trees. On large mature trees two, three, or four buckets may be used, but if trees are tapped excessively they lose vigor and large areas of sapwood are killed, which of course is not desirable.

The sap is collected in the buckets and strained before entering the evaporator where it is boiled down. The evaporation should be accomplished as rapidly as possible in order to produce a light-colored syrup of fine flavor. As the sap is boiled down a scum forms which should be skimmed off. The syrup is canned hot or cold and should weigh 8 to 10 pounds per gallon. When the syrup is further concentrated and cooled, the sugar crystallizes out. Both hard and soft maple sugar may be obtained on the market.

Palm sugar.—Palms as a source of sugar may in the future challenge the supremacy of the cane and sugar beet. It has been estimated that over 1,000,000,000 pounds of palm sugar are produced annually in the tropical regions of the world. There are twelve or more species of palms that yield sugar, *Arenga saccharifera,* the sugar or sago palm, being one of the most important.

To obtain the sap, the spadix which bears the flowers is cut off near its base and the sap that flows out is caught in various types of receptacles. The Arenga palm may be tapped when 9 or 10 years of age and will yield about 3 quarts of sap a day for two years. The sap, often containing as high as 16 per cent

sugar, is boiled down to a syrup which on cooling forms a dark-colored sugar of greasy consistency and having a peculiar flavor. The native population of India uses vast quantities of this sugar. D. C. F.

WINTER COURSES IN GARDENING FOR AMATEURS

ELEMENTARY COURSE

The elementary course in various phases of gardening for amateurs, which has been conducted at the Garden for the past few years, will be repeated in 1935. As formerly, it will commence in January, since it is believed that the course is of more value when given earlier in the year. The class will meet in the lecture room of the museum building (entrance at Tower Grove and Cleveland Avenue gate) at 3:45 p. m., Tuesday afternoons of each week.

REGISTRATION: It is desirable that registration be made by letter, with check payable to the Missouri Botanical Garden enclosed, as soon after December 20 as possible. Tickets will be ready for distribution on day of first lecture. Registration fees will also be received on January 8 at the lecture hall, at 3:00 o'clock.

FEES: The registration fee is $5.00 for each person, and tickets are not transferable.

The outline of the subjects to be discussed follows:

January 8—Brief discussion of catalogues, horticultural magazines, and bulletins. Illustrated lecture and instruction on rock gardens and wall gardens. The use of hot-beds and cold-frames .....Kohl

January 15—Trees and shrubs:
Pruning of shrubs at planting time.
Summer and winter pruning of trees and shrubs with relation to the time of bloom, i. e., trees and shrubs flowering in spring from buds formed the previous season; those blooming in summer on wood made during the current season .....Beilmann

January 22—Annuals, perennials. Illustrated lecture.....Kohl

January 29—General care of trees; the importance of tree surgery and the use of fertilizers.....Beilmann

February 5—Roses. Illustrated lecture.....Kohl

February 12—Lawns:
Seed lawns: Preparation of the soil, seed selection, fertilizers.
Stolon lawns: Methods of planting by means of stolons and plugging.
Lawns and their subsequent care.
Experimental lawn plots.....Pring

February 19—Practical demonstration (students participating) in growing plants from seeds.....Fairburn

February 26—Iris, peonies, and bulbs. Illustrated lecture....Kohl

March 5—Controlling insect pests. Material to use.....Beilmann

March 12—Water gardens. Illustrated lecture.
Construction of pools.
Preparation of soil and planting.
Caring for hardy and tropical water-lilies during growing season.
Propagation by seeds, tubers, leaves.
Breeding.
Winter storage .....Pring

March 19—Demonstration in pruning and spraying, including use of power and hand sprayers and dusters.....Beilmann

March 26—Practical demonstration in the greenhouse of potting seedlings.
Preparation of soil for sowing seed outdoors.....Fairburn

ADVANCED COURSE

The advanced course in gardening for amateurs will start February 7. Greenhouse facilities have been improved considerably and the course of instruction revised to include a more complete training in the practical phases of gardening. The classes will be held in the experimental greenhouses where the students will have an opportunity to study soil management, conduct fertilizer experiments, raise plants from seed and cuttings, force spring bulbs, learn to identify and how to control common garden pests, and obtain information concerning many other garden problems. The class will be held from 10 to 12 a. m. Thursday of each week.

REGISTRATION: Limited to 30 students and open only to those who have taken the elementary course in gardening.

FEE: The registration fee is $10.00 per student and tickets are not transferable. Write or phone the Garden for reservations.

February 7—The nature of the plant:
A study of the life history of flowering plants including the structure and functions of roots, stems, leaves, buds, flowers, fruits, and seeds.

February 14—Soil management:
Chemical, physical, and biological relationships of soil. Preparation of fertile garden soil by students in the greenhouse.

February 21—Fertilizers:
What, when, and how to use organic and inorganic fertilizers for soil improvement. Fertilizer exhibit. Students will start an experiment in the greenhouse to show the effects of various fertilizer treatments on plant growth.

February 28—Insects and diseases:
Identification, injury, and control of common garden pests. Exhibit in the greenhouse showing various insects, diseases, injury to plants, insecticides, fungicides, sprayers and dusters.

March 7–April 4—Plant Propagation:
The propagation of plants is one of the most important and interesting phases of gardening. Five class periods will be devoted to this subject in order that the students may become familiar with a wide variety of plants and their methods of increase. The class will conduct experiments on propagation according to the following outline:

a. Seed sowing:
Students will raise various annuals and perennials from seed, and the plants may be transferred to their own gardens when the weather permits.

b. Stem cuttings:
Coleus, geranium, verbena, salvia, begonia, alternanthera.

c. Leaf cuttings:
Rex begonia, cyperus, peperomia, African violet.

d. Root cuttings:
Peony, oriental poppy, sansevieria, plumbago.

e. Hardwood cuttings:
Willow, rose, grape, privet.

f. Rootstock or rhizome:
Iris, canna, lily-of-the-valley, calla, caladium.

g. Tubers:
Potato, artichoke, hardy and tropical water-lilies.

h. Tuberous roots:
Dahlia, sweet potato.

i. Bulbs, bulb scales, corms and cormels:
Lily, tulip, narcissus, hyacinth, gladiolus, amaryllis, and crocus. Experiments on bulb forcing in the greenhouse.

j. Viviparous leaves:
Bryophyllum, tolmiea, water-lily, water-fern.

k. Stolons:
Strawberry, anthericum, sempervivum, water-lettuce, ferns and bent grass.
l. Layering:
Ivy, rubber plant, dracaena, croton, hydrangea.
m. Grafting and budding:
Cactus, rose, fruit trees.

April 11—Potting of plants raised from seed.

April 18—Potting of plants raised from cuttings. The care of house plants.

April 25—Survey of desirable annuals and perennials. Review of garden maintenance and general discussion. Books and bulletins on gardening.

NOTES

Mr. George H. Pring, Superintendent of the Garden, has been reelected president of the St. Louis Horticultural Society.

Dr. Earl E. Sherff, Head, Department of Science, Chicago Normal College, Chicago, Ill., consulted the library and herbarium recently.

Mr. G. H. Pring, Superintendent of the Garden, spoke before the Cemetery Superintendents' Association, December 12, on "The Effect of Drought on Plants."

"In the Garden World," a column of the New York TIMES, December 2, appeared an article "Succeeding With Succulents Indoors" by Lad Cutak, in Charge of Succulents at the Garden.

Vol. XXI, No. 4, of the ANNALS OF THE MISSOURI BOTANICAL GARDEN has been issued and contains the following papers: "Two New Asclepiads from Szechuan, China" and "New or Otherwise Noteworthy Apocynaceae of Tropical America. IV" by Robert E. Woodson, Jr.; "Hymenogaster and Related Genera" by C. W. Dodge and S. M. Zeller; "Proposals for Amendment of Article 20 of the International Rules of Nomenclature" by C. W. Dodge.

STATISTICAL INFORMATION FOR NOVEMBER, 1934

GARDEN ATTENDANCE:

Total number of visitors	79,587

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought	12
Total number of books and pamphlets donated	125

PLANT ACCESSIONS:

Total number of plants and seed packets donated	40

HERBARIUM ACCESSIONS:

By Purchase—

Bush, B. F.—Plants of Missouri	381
Bush, B. F.—Plants of Kansas	300
Degener, Otto—Plants of the Hawaiian Islands	100
Lundell, C. L.—Plants of British Honduras	55
Schipp, Wm. A.—Plants of British Honduras	138
Thompson, J. Wm.—Plants of Washington	1000

By Gift—

Bush, B. F.—Plants of Texas	6
Cottam, Clarence—Plants of Washington	2
Cutak, L.—*Sarcobatus vermiculatus* (Hook.) Torr. from Wyoming	1
Davison, Curtis W.—*Phedranassa chlorantha* Herb. from Horticulture	1
Dodge, Carroll W.—Plants of Costa Rica	46
Larsen, Esther L.—Plants of Delaware	115
Steyermark, Julian A.—*Grindelia* from western United States	6
Stifler, C. B.—*Elaphomyces* sp., from Pennsylvania	1
Hitchcock, C. L.—*Lycium* from Argentina	26
Woodson, R. E., Jr.—*Vallesia laciniata* Brandg. from Mexico	1

By Exchange—

California Academy of Sciences—Plants of the Pacific Coast region and of the Galapagos Islands	122
The Academy of Natural Sciences of Philadelphia by F. W. Pennell—Photographs of *Mertensia*	4
State College of Washington—Plants of Washington and Oregon	100
Thompson, J. Wm.—Plants of Washington	55
University of California—Plants of China collected by Joseph F. Rock	722
Total	3182

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SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date to the death of Mr. Shaw, in 1889, the Garden was maintained under the personal direction of its founder, and while virtually a private garden it was, except at certain stated times, always open to the public. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was designated by Mr. Shaw as its official title and in his will or in any of his writings he specifically referred to it as the "Missouri Botanical Garden." By a provision of Mr. Shaw's will the Garden passed at his death into the hands of a Board of Trustees. The original members of the Board were designated in the will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will, the immediate direction of the Garden is vested in a Director, appointed by the Board of Trustees. The Garden receives no income from city or state, but is supported entirely from funds left by the founder.

The city Garden comprises 75 acres, where about 12,000 species of plants are growing. There is now in process of development a tract of land of over 1,500 acres outside the city limits which is to be devoted to (1) the propagation and growing of plants, trees, and shrubs, designed for showing either indoors or outside, at the city Garden, thus avoiding the existing difficulties of growing plants in the city atmosphere; (2) gradually establishing an arboretum as well as holding a certain area as a forest reservation, with the idea that possibly at some future time this may become the new botanical garden.

The Garden is open to the public every day in the year, except New Year's Day and Christmas—week days from 8:00 a. m. until one-half hour after sunset; Sundays from 10 a. m. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Place, on the Sarah car line (No. 42). Transfer south from all intersecting lines.

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